Review Article

A Review on Anti Dermatophytosis Potential of Medicinal Plants: *In-Vitro*, *In-Vivo* and Important Components

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Abstract

Background and Aim: Dermatophytosis refers to superficial fungal infection of keratinised tissues that increase remarkable costs several plants were used as traditional medicine to treat fungal diseases. The current review aimed to provide an update on several plants used as antidermatophytosis agents and investigate the action mechanism of each plant.

Materials and Methods: This systematic review was conducted on the literatures available in databases PubMed, Scopus, Web of Science and Science Direct using the search engine Google Scholar, and the following search terms: Dermatophytosis and Herbal/Herbal Medicine and Dermatophytosis treatment.

Results: Forty plants were identified and information on their scientific and common name, family, parts, preparation, extraction method, fractions, solvents, phytochemical categories, compounds, dermatophyte species and inhibitory concentrations was provided from multiple *in vitro*, *in vivo* and clinical studies

Conclusion: Herbals are the most effective agents on dermatophytosis which have antidermatophytosis effects due to their essential compounds.

Keywords: Dermatophytosis, Herbal Medicine, Cutaneous Fungi

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Introduction

Dermatophytosis refers to superficial fungal infections of keratinised tissues, caused by several dermatophyte species[1]. These species were divided into three groups of anthropophilic, zoophilic and geophilic according to host preferences and natural habits. Fungi may cause human infections in all three categories[2]. These organisms, which attack to skin, hair and nails are classified as *Microsporum*, *Trichophyton* and *Epidermophyton*[3]. Dermatophytosis are called Tinea according to the site of infection[4,5]. Typically, it results in a red, scaly, itchy, circular rash and hair loss. Symptoms appear 4 to 14 days after exposure[6]. Using public showers, contact sports, contact with animals, poor immune function, and obesity are the most common risk factors. Tinea can spread between people or from other animals. The

diagnosis is based on the symptoms and appearance[6]. For laboratory diagnosis, collected specimens, including hair and skin scrapings, nail clips and subungual debris are examined by direct microscopy and culture on media. In microscopic detection of the specimens, potassium hydroxide (KOH) solution (10-20%) with dimethyl sulfoxide (4%) (DMSO) are used. To isolate the fungi, samples are cultured into Sabouraud Dextrose Agar (SDA) with cycloheximide and chloramphenicol[7,8].

About 21–26% of the world's populations are infected with dermatophytes and the incidence of the disease is increasing progressively[9]. The prevalence of dermatophyte infection varies according to geographical areas. In the distribution pattern, this variance is attributed to the social practices, movements of troops, immigration and frequent worldwide traveling[10]. The treatment of tinea infection mainly contains oral and/or topical formulations of azoles (itraconazole and fluconazole) or allylamines, and terbinafine[11].

Worldwide studies showed that drug resistance among dermatophytes is increasing. Azamabuja *et al.*, found higher values of minimum inhibitory concentrations (MIC) for fluconazole and itraconazole, 66.7% and 25%, respectively[12]. A study conducted by Singal *et al.*, in North India showed that there was treatment failure to griseofulvin among the Tinea capitis patients[13]. Agarwal *et al.*, found 11% strains resistant against fluconazole and 9% against terbinafine[14]. Other studies relieved that there are more resistant to fluconazole[15-17]. Due to the antifungal resistance, the side-effects and lack of efficacy with some of the current drugs, there has been an increasing search for new antifungal herbal compounds[18]. To treat fungal diseases, a large number of plants are being used as traditional medicinal practitioners in the world. This review aimed to provide an update on the some plants and investigate the role of active components of each plants and the correlation between them and antifungal activity.

Materials and Methods

Study design

A systematic review was conducted on the literature available on the medicinal utility of certain plants as antidermatophytosis agents using PubMed and Google Scholar and the following search terms: Dermatophytosis and Plants / Medicinal Plant and Dermatophytosis treatment.

***In-vitro* study**

Data from in-vitro studies from some of the more recent investigations are summarized in Table 1.

***In-vivo* study**

Totally 12 of 26 genus of our herbal studies reviewed, were surveyed against dermatophyte species in in-vivo study. Data from recent investigations are summarized in Table 2.

Clinical study

The clinical efficacy of herbs can also be the subject of investigation paralleled with the importance of herbal medicine in in-vitro and in-vivo studies. Data from our studies showed that only *Camellia sinensis* could effectively improve the symptoms of tinea pedis in elderly patients. Ikeda *et al*, has been expressed a significant reduction in the size of the affected area after 12 weeks of treatment with *Camellia sinensis* (the polyphenols of Camellia sinensis (Green tea))[19].

Future perspectives

Extracts and essential oils of plants with various natural compounds have important roles with different and valuable pharmacological activities. Despite the advances in biomedical research and novel technologies, death of infections is one of the mortality factor in the world[20]. New infections and anti-microbial drug resistance both in human and livestock lead the scientist to discovery of new compounds from herbal. This research showed that some extracts such as: *Calendula officinalis*, *Cedrus spp*., *Myrtus communis*, *Zingiber officinale*, and some essential oils like: *Salvia officinalis*, *Myrtus communis*, *Chenopodium botrys* can inhibit the dermatophyte growth; they can be used in different pharmaceutical dosage forms to treat the infections.

This review confirms the potential uses of herbal extracts against all the types of dermatophyte species tested in-vitro. The primary benefits of using plant-derived medicine include strong efficacy, renewable source capability, cost effectiveness, and fewer side effects[21-23]. There are several disadvantages associated with the topical use of herbal extracts, such as loss of hair, itching, irritation, nausea, headache, and vomiting[24].

Table 1: *In-vitro* antifungal activity

NO	- Scientific Name - Common Name - Family	Parts / Preparative	Method of Extraction/ Fraction	Solvent	Phytochemical Category	Compounds	Dermatophyte Species	Plant		Control	Find / Result	Reference
								MIC	MFC	MIC/ Antifungal		
1	- *Althaea officinalis* L. - Marsh-mallow - Malvaceae	Leaves / Extraction	Soxhlet	Methanol Hexane	Carbohydrates/glycosides Oils Phenolic compounds Proteins/amino acids Steroid Tannin Terpenoid Reducing sugar	-------	*M. canis* *M. gypseum* *T. rubrum* *T. schoenleinii* *T. mentagrophytes* *E. floccosum*	6.4 (mg/ml)		1.6 1.6 1.6 1.6 0.8 1.6 (mg/ml) Griseofulvin	The Percent of Inhibition of the Crude Extract of *Althaea officinalis* L. Compared to Griseofulvin Against Different dermatophytes: *M. canis* → 10% *M. gypseum* → 2% *T. rubrum* → 2% *T. schoenleinii* → 2% *T. mentagrophytes* → 2% *E. floccosum* → 2% Griseofulvin → 100%	[25]
2	- *Althaea officinalis* L. - Marsh-mallow - Malvaceae	Whole plant / Extraction	Maceration	Ethanol 70%	Phenolic compounds	--------	*M. gypseum* *T. mentagrophytes* *T. rubrum*			62.5 62.5 62.5 (µg/ml) Amphotericin B	At any concentration, *Althaea officinalis* L. had no effect in fungi growth	[26]
3	- *Calendula officinalis* L. - Pot marigold, ruddles, common marigold, Scotch marigold - Compositae	Fresh leaves, roots, flower and rhizome/ Extraction	Maceration	Sterile distilled water	Glycosides Glucuronides	-------	*T. rubrum* *T. mentagrophytes*	0.27 6.27 (mg/ml)	0.27 6.27	0.4- 25 (µg/ml) Miconazole	Antifungal activity *Calandula officinalis* L. showed the high antidermatophytic activity.	[27]
4	- *Calendula officinalis* L. - Pot marigold, ruddles, common marigold, Scotch marigold - Compositae	Dried leaves, roots, flower and rhizome/ Extraction	Maceration	Ethanol	Glycosides Glucuronides Oils	------- ------- Oleanic acid	*T. rubrum* *T. mentagrophytes*	0.25 2.25 (mg/ml)	0.25 2.25	0.4- 25 (µg/ml) Miconazole	Antifungal activity *Calandula officinalis* L. showed the high antidermatophytic activity.	[27]

5	- *Calendula officinalis* L. - Pot marigold, ruddles, common marigold, Scotch marigold - Compositae	Leaves / Extraction	Soxhlet	Methanol Hexane	Alkaloids Carbohydrates/glycosides Flavonoids Phenolic compounds Proteins/amino acids Saponin Steroids Tannin Terpenoids Reducing sugar	-------	*M. canis* *M. gypseum* *T. rubrum* *T. schoenleinii* *T. mentagrophytes* *E. floccosum*	0.7 1.4 1.4 0.4 0.2 0.2 (mg/ml)	6.4 3.2 1.6 0.8 0.8 0.8 (mg/ml)	6.4 3.2 1.6 0.8 0.8 0.8 (mg/ml) Griseofulvin	The Percent of Inhibition of the Crude Extract of *Calendula officinalis* L. Compared to Griseofulvin (100% Inhibition) Against Different dermatophytes: *M. canis* → 37.5% *M. gypseum* → 37.5% *T. rubrum* → 66.6% *T. schoenleinii* → 50% *T. mentagrophytes* → 26.3% *E. floccosum* → 65% Griseofulvin → 100%	[25]
6	- *Cedrus atlantica* (Endl.) Manetti ex Carriere - Atlas cedar - Pinaceae	Wood / Essential oil	Steam distillation	-------	Terpenes	α-Himachalene α-Longipinene Hamachalol Cuprenene	*T. erinacei* *T. mentagrophytes* *T. rubrum* *T. schoenleinii* *T. soudanense* *T. tonsurans*	2 1 1 1 0.25 0.5 (mg/ml)	4 2 2 2 0.5 1 (mg/ml)	Griseofulvin	Ketoconazole was used as control. Growth inhibition (mm)± SD of *Trichophyton spp.* on Sabouraud agar plates: Using 25 mg per disc: *T. erinacei* → 7.3 ± 0.76 *T. mentagrophytes* → 9.2 ± 0.29 *T. rubrum* → 1 ± 0.00 *T. schoenleinii* → 7.3 ± 0.58 *T. soudanense* → 8.7 ± 0.58 *T. tonsurans* → 7.2 ± 0.76 Using 12.5 mg per disc: *T. erinacei* → 3.3 ± 0.76 *T. mentagrophytes* → 5.3 ± 0.29 *T. rubrum* → 0.7 ± 0.29 *T. schoenleinii* → 4.3 ± 1.15 *T. soudanense* → 5.8 ± 0.76 *T. tonsurans* → 3.8 ± 0.29	[28]
7	- *Cedrus atlantica* (Endl..) Manetti ex Carriere - Atlas cedar - Pinaceae	Leaves / Purchased essential oil	-------	-------	Monoterpenes	-------	*E. floccosum* *M. canis* *T. mentagrophytes* *T. rubrum* *E. stockdale*			Acetone acetone/iso-amyl acetate	At 250 µg/ml concentration of extract, no zone of inhibition was observed.	[29]

8	*Cedrus libani* A. Rich - Lebanon Cedar - Pinaceae	Wood / Fixed oil	-------	-------	Fixed oil	-------	*E. floccosum* *T. rubrum* *T. mentagrophytes*	0.25-1 0.25-2 0.5-1 (µg/ml)	0.5-4 0.5-4 4-16 (µg/ml)	Terbinafine, Tolnaftate and Miconazole	Cedrus oil (natural oil) possessed acceptable antifungal activity against dermatophytes in vitro with MIC ranging between 0.5 and 2 g/ml.	30
9	- *Cocos nucifera* L. - Coconut tree - Arecaceae	Dried Endosperms / Purchased hair oil	-------	-------	Fixed oil	Lauric acid Myristic acid Palmitic acid Stearic acid Oleic acid Linoleic acid	*M. canis* *M. gypseum* *T. rubrum* *T. mentagrophytes*				Oil concentration in which the growth inhibition per cent of dermatophytes was 100% was: *M. canis* → 5-20% *M. gypseum* → > 20% *T. rubrum* → 0.5% *T. mentagrophytes* → 1-20% *T. mentagrophytes* is most susceptible to coconut oil.	31
10	- *Cocos nucifera* L. - Coconut tree - Arecaceae	Shell / Extraction	Soxhlet	Ethanol 95%	Phenolic compounds	-------	*M. canis* *M. gypseum* *M. audouinii* *T. mentagrophytes* *T. rubrum* *T. tonsurans* *T. violaceum* *E. floccosum*	50 50 50 50 50 50 50 100 (µg/ml)			The rate of growth of the fungi was recorded at intervals of one week, for four consecutive weeks. The antifungal action of coconut shell extract may be attributed mainly to its high phenol content.	32
11	- *Cocos nucifera* L. - Coconut tree - Arecaceae	Shell / Extraction and fraction	Soxhlet/Fractions	Methanol (Extract) Chloroform (Fraction) Ethyl acetate (Fraction) Water	Phenolic compounds Saturated and unsaturated fixed oils	Caprylate Lauric acid Palmilate acid Margorate Arachidic acid Myristic acid Stearic Acid	*M. canis* *M. gypseum* *T. mentagrophytes* *T. rubrum* *T. verrucosum*				The Percent of Inhibition of the 4 Extracts of the Plant (methanol, chloroform, ethyl acetate, Aqueous extract) respectively, Against different dermatophytes reading at 30◌̊ C after 72h	33

				(Fraction)		Lignoceric Acid Behenic Acid Palmitic acid Cerotate Oleate acid Laurate acid n-Heptaecenoate Tridecatriecnoate Decylacrylate Tetradecatrienoate Undecadienoate Pentadecatrienoate Hexadecadienoate Plmitoleate Heptadectrienoate Octadecatrienoate Oleate Stearate Eicosatrienoate Hexacosenate DihydroxyphenylacEtic acid			compared to negative control group (0%) was: *M. canis* (methanol) → 81%, 62%, 80% and 74% *M. gypseum* (methanol) → 88%, 72%, 85% and 74% *T. mentagrophytes* (methanol) → 77%, 72%, 82% and 65% *T. rubrum* (methanol) → 84%, 71%, 88% and 65% *T. verrucosum* (methanol) → 90%, 65%, 90% and 65%	
12	- *Euphorbia hirta* L. - Asthma-plant, Tawa tawa - Euphorbiaceae	Leaves/ Extraction	Soaked	Distilled water	1- Tannins 2- Flavonoids 3- Alkaloids= Saponins	-------	*T. mentagrophytes*	0.2 (mg/ml) Tioconazole	For crude aqueous extract, concentration of 25%, 50%, 75% and 100% applied mean zones of inhibition of 8.33 mm, 9.33 mm, 11.00 mm and 13.33 mm, respectively	[34]
13	- *Euphorbia hirta* L. - Asthma-plant, Tawa tawa - Euphorbiaceae	Leaves/ Extraction	Maceration	Ethanol	1- Alkaloids= Saponins 2- Flavonoids = Tannins	-------	*T. mentagrophytes*	0.2 (mg/ml) Tioconazole	For crude ethanolic extract, concentration of 25%, 50%, 75% and 100% applied mean zones of inhibition of 12.67 mm 13.67 mm, 16.00 mm and 20.00 mm, respectively	[34]
14	- *Euphorbia granulata* Forssk. - ------- - Euphorbiaceae	Whole plant / Extraction	Maceration	Dichloromethane	-------	-------	*M. canis*	Miconazole	Linear growth (mm) of *M. canis* sample with dichloromethane extract of plant was 10 mm; which in comparison with negative control group suggested inhibitory potential of 90%.	[35]

15	- *Euphorbia abyssinica* J.F. Gmel. - Desert Candle - Euphorbiaceae	stem bark and the latex / Extraction	Maceration	Methanol	-------	-------	stem bark: *E. floccosum* *T. mentagrophytes* *T. rubrum* *T. violaceum* *M. canis* *T. tonsurans* *M. gypseum* Latex: *E. floccosum* *T. mentagrophytes* *T. rubrum* *T. violaceum* *M. canis* *T. tonsurans* *M. gypseum*	3.13 6.25 3.13 6.25 3.13 6.25 25 3.13 12.5 12.5 12.5 6.25 25 25 (mg/ml)	1.0 1.0 0.5 0.5 0.5 1.0 2.0 (µg/ml) Voriconazole	*M. gypseum* the least susceptible of the dermatophytes tested (significant mean 14.641). According to Time Kill, curve *T. mentagrophytes*, *M. gypseum* and *E. floccosum* cells were killed by the higher concentrations (4MIC and 2MIC) of the plant extracts.	[36]
16	- *Lawsonia inermis* L. - Henna - Lythraceae	Leaves / Extraction of wild type	Maceration	Sterile saline	Flavonoids Quinoids Naphthalene derivatives Coumarins Xanthones Phenolic Glycosides Pentacyclic triterpenes	ß-Sitosterolglucosides Luteolin Botulin Lupeol Gaic Acid Lawsone 2-hydroxy-1,4-naphtoquinone Hennadiol 3β, 30-dihydroxylupane	*T. rubrum* *T. mentagrophytes* *M. canis* *T. tonsurans* *E. floccosum* *T. violaceum*		Miconazole	Henna paste showed the high antifungal activity against: 15 *T. rubrum* strains → 20 to 30 mm inhibition zone 29 *T. rubrum* strains → 40 to 50 mm inhibition zone 4 *T. mentagrophytes* strains → 20 to 30 mm inhibition zone 4 *T. mentagrophytes* strains → 40 to 50 mm inhibition zone 5 *M. canis* strains → 25 mm inhibition zone 1 *M. canis* strain → 30 mm inhibition zone 1 *T. tonsurans* strain → 30 mm inhibition zone 5 *T. tonsurans* strains → 40 mm inhibition zone 4 *E. floccosum* strains → 40 mm inhibition zone 2 *T. violaceum* strains → 20 mm inhibition zone	[37]
17	- *Lawsonia inermis* L. - Henna - Lythraceae	Leaves and young shoots/ Extraction of wild type	Maceration	Chloroform	-------	-------	*T. mentagrophyte* *T. rubrum* *M. gypseum* *M. fulvum*	>12.5 >12.5 >12.5 >12.5 (mg/ml)	Clotrimazole	The activity of *Lawsonia inermis* L. in term of inhibition zone diameter in decreasing order can be stated as Water > Methanol > Chloroform.	[38]

18	- *Lawsonia inermis* L. - Henna - Lythraceae	Leaves and young shoots/ Extraction of wild type	Maceration	Methanol	-------	-------	*T. mentagrophyte* *T. rubrum* *M. gypseum* *M. fulvum*	>12.5 >12.5 >12.5 >12.5 (mg/ml)		Clotrimazole	"	[38]
19	- *Lawsonia inermis* L. - Henna - Lythraceae	Leaves and young shoots/ Extraction of wild type	Decoction	Double distilled water	-------	-------	*T. mentagrophyte* *T. rubrum* *M. gypseum* *M. fulvum*	6.25-12.5 >12.5 >12.5 6.25-12.5 (mg/ml)		Clotrimazole	"	[38]
20	- *Lawsonia inermis* L. - Henna - Lythraceae	Leaves / Crude extract of wild type	Soxhlet	Methanol	-------	-------	*M. audouinii* *M. ferrugineum* *T. megninii* *T. tonsurans* *T. rubrum*	25 25 25 25 25 (mg/ml)	50 100 200 200 50 (mg/ml)	Ketoconazole	Minimum inhibitory concentration was recorded at 25 mg/ml for all dermatophytes while fungicidal action was recorded at concentrations of 50 mg/ml for *M. audouinii* and *T. rubrum*, 100 mg/ml for *M. ferrugineum* and 200 mg/ml for *T. megninii* and *T. tonsurans*. These results demonstrated that *Lawsonia inermis* L. has antidermatophyte activities and could be a good source for the production of plant based antifungal drugs.	[39]
21	- *Lawsonia inermis* L. - Henna - Lythraceae	Leaves / Crude extract of home-grown	Maceration	Ethanol*	-------	-------	*T. mentagrophytes* *T. verrucosum* *T. violaceum*	7.5 10 5 (mg/ml)		Ketoconazole	*T. mentagrophytes* and *T. violaceum* were found more sensitive to ethanol extract with MIC of 7.5 mg/ml. However, all *Trichophyton species* were found sensitive to ethanol at a concentration of 10 mg/ml. *only ethanolic extraction was used on dermatophyte species	[40]

22	- *Matricaria recutita* L. - German chamomile - Compositae	Flower / Essential oil	Hydro-distillation	-------	Terpenes	a-phellanderene (E)-b-ocimene g-terpinene P-cymenene a-terpinene Isomenthyl acetate E-b-farnesol Spathulenol a-bisabolol oxide A Z, E-farnesol a-bisabolol Chamazulene Trans-trans-farnesol Isopropyl hexadecanoate	*M. canis* *M. gypseum* *T. tonsurans* *T. mentagrophytes* *T. rubrum*	27.1 >80 16.5 72.0 36.8 (µg/ml)		16.2 35.3 26.8 37.3 39.4 (µg/Disc) Ketoconazole	*Matricaria recutita* L. could be considered as a potential candidate for producing commercial antifungals suitable for treatment of dermatophytosis.	[41]
23	- *Myrtus communis* L. - Myrtle - Myrtaceae	Leaves /Extraction	Percolation	Ethanol	-------	-------	*M. canis* *T. mentagrophytes* *E. floccosum*	1 1.5 1 (mg/ml)	1 1.5 1 (mg/ml)	Clotrimazole	Chloroform, n-hexane and petroleum benzene have no effect on the growth of dermatophytes	[42]
24	- *Myrtus communis* L. - Myrtle - Myrtaceae	Leaves / Essential oil in sweet almond oil	-------	-------	1-Monoterpene-hydrocarbons 2-Oxygenated-monoterpenes 3-Sesquiterpene-hydrocarbons	Tricyclene 1,8-Cineole Limonene p-Cymene Linalool	*M. canis* *M. gypseum* *T. mentagrophytes* *T. terrestre* *T. erinacei*	2 3 1.5 3 2 (mg/L)	3 5 5 6 5 (mg/L)	Griseofulvin Terbinafine Itraconazole Posaconazole Voriconazole	*Myrtus communis* L. has not effect on dermatophytes species significantly.	[43]
25	- *Myrtus communis* L. - Myrtle - Myrtaceae	Leaves /Extraction and fraction	Maceration /Fractions	Methanol 80% (Extract) Petroleum ether (Fraction) Dichloromethane (Fraction) Ethyl acetate (Fraction)	Phenolic compounds Flavonoids Phenolic acid Tannins	oenothein B, eugeniflorin D2, tellimagrandins I and tellimagrandins II gallic acid quinic acid 3,5-di-O-gallate myricetin 3-O-b-D-xyloside myricetin 3-O-b-D	Total methanolic: *M. canis* *M. gypseum* *T. mentagrophytes* Petroleum ether: *M. canis* *M. gypseum* *T. mentagrophytes* Dichloromethane: *M. canis*	1.250 1.250 1.250 >5.000 >5.000 >5.000 >5.000		1.000 5.000 4.000 (µg/Disc) Griseofulvin	Ethyl acetate and total methanolic extracts had the best antifungal effects against three species of dermatophytes compared with any other fractions.	[44]

						galactoside myricetin 3-O-b- D-galactoside 6-O-gallate myricetin 3-O-a-L-rhamnoside	*M. gypseum* *T. mentagrophytes* Ethyl acetate: *M. canis* *M. gypseum* *T. mentagrophytes* Hydroalcoholic: *M. canis* *M. gypseum* *T. mentagrophytes*	>5.000 >5.000 0.187 0.375 0.375 5.000 5.000 5.000 (µg/Disc)				
26	- *Myrtus communis* L. - Myrtle - Myrtaceae	Leaves and flowers / Essential oil	Hydro-distillation	-------	1- Monoterpene hydrocarbons 2- Oxygenated monoterpenes 3- Sesquiterpene hydrocarbons 4- Oxygenated sesquiterpenes 5-Phenyl propanoids	Isobutylisobutyrate α-Thujene α-Pinene β-Pinene Isobutyl 2-methylbutyrate 2-Methylbutyl isobutyrate δ-3-Carene p-Cymene 1,8- γ-Terpinene 2-Methylbutyl 2-methylbutyrate Terpinen-4- α-Terpineol Estragole Linalyl α-Terpinyl acetate Geranyl acetate Methyleugenol (E)-β-Caryophyllene α-Humulene Dione Ac Caryophyllene oxide	*E. floccosum* *M. canis* *M. gypseum* *T. mentagrophytes* *T. mentagrophytes* (var. *interdigital)* *T. rubrum* *T. verrucosum*	0.64 0.64 1.25 1.25 1.25 0.64 1.25 (mg/ml)	0.64 0.64 1.25 1.25 1.25 0.64 1.25 (mg/ml)	16 128 ≥128 32 ≥128 32 >128 (µg/ml) Fluconazole	Bioactive concentrations of *Myrtus communis* L. suggested a potential oral and topical application.	[45]
27	- *Rosmarinus officinalis* L. - Rosemary - Lamiaceae	Leaves / Essential oil in sweet almond oil	-------	-------	1- Hydrocarbon monoterpenes 2- Oxygenated monoterpenes 3- Hydrocarbons sesquiterpenes 4- Oxygenated	1,8-Cineole a-Pinene Camphor Limonene b-Pinene	*T. mentagrophytes*				The percent of inhibition of *Rosmarinus officinalis* L. compared to negative control group (0%) against : *T. mentagrophytes* → MIC: 5% *T. mentagrophytes* → MFC: 7.5%	[46]

					sesquiterpenes							
28	- *Rosmarinus officinalis* L. - Rosemary - Lamiaceae	Leaves / Extraction	Maceration	Ethanol (90%)	-------	-------	*T. rubrum* *T. mentagrophytes* *M. gypseum*	62.5 125 250 (µg/ml)	250 250 250 (µg/ml)	1.9 1.9 15.6 (µg/ml) Amphotericin B	*Rosmarinus officinalis* L. showed good action against dermatophytes, causing alterations in hyphae and inhibiting fungal growth.	[47]
29	- *Rosmarinus officinalis* L. - Rosemary - Lamiaceae	Leaves / Essential oil in sweet almond oil	-------	-------	1- Monoterpene hydrocarbons 2- Oxygenated monoterpenes 3- Sesquiterpene hydrocarbons 4- Oxygenated sesquiterpenes	α-Pinene Camphene β-Pinene Myrcene o-Cymene Limonene 1,8-Cineole Camphor Isobornyl acetate β-Caryophyllene	*M .canis* *M .gypseum* *T. mentagrophytes* *T. terrestre* *T. erinacei*	2.5 2.5 5 5 1.5 (mg/L)	7.5 7.5 7.5 7.5 1.5 (mg/L)	Griseofulvin Terbinafine Itraconazole Posaconazole Voriconazole	*Rosmarinus officinalis* L. has not effect on dermatophytes species	[43]
30	- *Rosmarinus officinalis* L. - Rosemary - Lamiaceae	Aerial parts/ Essential oil	Hydro-distillation	-------	Terpenes	Pinene Cineole Linalool (Main compounds)	*T. mentagrophytes* *T. rubrum* *E. floccosum* *M. gypseum* *M. canis*	2.5 4 4 2 1.5 (mg/ml)	5 8 4 2 3 (mg/ml)	0.5 0.5 1.5 0.5 0.25 (µg/ml) Itraconazole	The oils of *Rosmarinus officinalis* L. (mean MIC: 2.8 mg·ml-1) presented weak activity.	[48]

31	- *Salvia officinalis* L. - Common sage - Lamiaceae	Aerial Parts / Essential Oil	Hydro-distillation	-------	1-Monoterpene hydrocarbons 2-Oxygen containing monoterpenes 3-Sesquiterpene hydrocarbons 4-Oxygen containing sesquiterpenes	Tricyclene α-Thujene α-Pinene Camphene β-Pinene Limonene 1.8-Cineole cis-Thujone trans-Thujone Camphor Borneol Terpinene-4-ol α-Terpineol Bornyl acetate E-Caryophyllene α-Humulene Viridiflorol Humulene oxide *	*E. floccosum* *T. rubrum* *T. mentagrophytes* *M. canis* *M. gypseum*	0.63-1.25 0.63-1.25 0.63-1.25 0.63-1.25 0.63-2.5 (µg/ml)	0.63-1.25 0.63-2.5 0.63-2.5 0.63-1.25 0.63-2.5 (µg/ml)	16 16-32 16-32 128 ≥128 (µg/ml) Fluconazole	The oil with 10.4% of cis-thujone and 20.5% of camphor was the most active, against dermatophyte strains. *MIC ranges of compounds of *Salvia officinalis* L. are mentioned here.	[49]
32	- *Salvia officinalis* L. - Common sage - Lamiaceae	Aerial Parts / Essential Oil	Hydro-distillation	-------	1-Monoterpene hydrocarbons 2-Oxygen containing monoterpenes 3-Sesquiterpene hydrocarbons 4-Oxygen containing sesquiterpenes	*α*-Thujene *α*-Pinene Camphene *β*-Pinene Myrcene p-Cymene 1,8-Cineole Camphenilone cis-Thujone trans-Thujone Camphor Borneol Isoborneol Myrtenal *α*-Terpineol Linalyl acetate Bornyl acetate Thymol Carvacrol *α*-Terpenyl acetate E-*β*-Caryophyllene *α*-Humulene Spathulenol Caryophyllene oxide Viridiflorol	*E. floccosum* *M. canis* *M. gypseum* *T. mentagrophytes* *T. mentagrophytes* (var. *interdigital*) *T. rubrum* *T. verrucosum*	0.64 1.25 1.25 1.25 1.25 0.64 1.25 (*µ*L/ml)	1.25 2.5 2.5 1.25 2.5 1.25 2.5 (*µ*L/ml)	16 128 128 16-32 128 16 >128 (*µ*L/ml) Fluconazole	Bioactive concentrations of *Salvia officinalis* L. oils do not affect mammalian macrophages and keratinocytes viability, so it was incorporated in skin care formulations for cosmetic purposes.	[50]

33	- *Triticum aestivum* L. - Common wheat - Poaceae	Whole Plant /Extraction	Maceration	Methanol	Carbohydrates Proteins Alkaloids Flavonoids Tannins Phenols Saponins Glycosides Steroids Terpenoids	-------	*M. canis*			In Crude sample (400µg/disc), zone of inhibition was 1.5 cm and relevant percent of inhibition was 38%. In control sample (ciprofloxacin 5µg/disc), zone of inhibition was 4 cm.	[51]
34	- *Urtica dioica* L. - Common Nettle - Urticaceae	Leaves / Extraction	Soxhlet	Methanol Hexane	1- Alkaloids= Steroids=Reducing sugar 2- Carbohydrates/glycosides=Flavonoids= Tannin	-------	*M. canis* *M. gypseum* *T. rubrum* *T. schoenleinii* *T. mentagrophytes* *E. floccosum*	6.4 6.4 6.4 6.4 6.4 6.4 (mg/ml)	1.6 1.6 1.6 1.6 0.8 1.6 (mg/ml) Griseofulvin	The percent of inhibition of the crude extract of different plants compared to Griseofulvin (100% Inhibition) against different dermatophytes was: *M. canis* → 12% *M. gypseum* → 10% *T. rubrum* → 8% *T. schoenleinii* → 2% *T. mentagrophytes* → 7% *E. floccosum* → 10% Griseofulvin → 100%	[25]
35	- *Urtica dioica* L. - Common Nettle - Urticaceae	Whole Plant / Extraction	Maceration	Methanol	Proteins (Lectins)	Agglutinin	*T. rubrum* *T. mentagrophytes* *M. canis*			All the test fungi started growing very slowly and they were inhibited significantly by the methanol extract. The slowest growth rate was exhibited by *T. rubrum* (4.5 mm per day)	[52]
36	- *Urtica pilulifera* L. - Common Nettle - Urticaceae	Whole Plant / Extraction	Maceration	Ethanol (70%)	-------	-------	*T. rubrum* *M. canis*		Econazole	Mean of % inhibition ±SD of fungi at 45 µg/ml concentration Compared to Econazole (5 µg/ml) (100% Inhibition) Against Different Dermatophytes was: *T. rubrum* → 81% *M. canis* → 88%	[53]
37	- *Zingiber officinale* Roscoe - Ginger - Zingiberaceae	Rhizome / Ointment and cream	reflux	Ethanol (96%)	Flavonoid Phenol Quinon Steroid/ triterpenoid	Gingerol Shogoal	*T. rubrum* *M. gypseum*	0.05 0.06 (µl/ml)	Ketoconazole	The results revealed a scientific validation for the use of *Zingiber officinale* Roscoe in the treatment of dermatophytic infections.	[54]

38	- *Chenopodium ambrosioides* L. - Mexican Tea - Chenopodiaceae	Leaves/ essential oil	Hydro-distillation/ Essential oil	--------	--------	--------	*T. rnentagrophytes* *M.audouinii*	50 50 (ppm)			The Percent of Inhibition of the Crude Extract of *Chenopodium ambrosioides* L. Against Different dermatophytes: *M. audouinii* → 100% *T. mentagrophytes* → 100%	[55]
39	- *Chenopodium ambrosioides* L. - Mexican Tea - Chenopodiaceae	Leaves/ essential oil	Hydro-distillation/ Essential oil via hydro-distillation method	--------	--------	--------	*M. gypseum* *T. rubrum*	1000 1000 (ppm)		Sterile water	Low concentration of 1000 ppm showed 100% inhibition of *T. rubrum* and *M . gypseum*	[21]
40	- *Chenopodium ambrosioides* L. - Mexican Tea - Chenopodiaceae	Leaves/ essential oils	Hydro-distillation/ Essential oil via hydro-distillation method	--------	Terpenoids	m-Cymene Myrtenol α-Terpene Caryophyllene oxide 2,3-Epoxy carvone m-Cresyl acetate 1,3,8-p-Menthatriene Carvacrol (Some of important compounds)	*M. gypseum* *T. rubrum*	700 350 (ppm)	>1000 500 (ppm)	5500 (ppm) Griseofulvin 4500 (ppm) Ketoconazole 1000 (ppm) Fluconazole	*T. rubrum* was found to be more sensitive than *M. gypseum*	[56]
41	- *Chenopodium ambrosioides* L. - Mexican Tea - Chenopodiaceae	Young fruits/Extraction	Maceration	Methanol/Dichloromethane (1:1)	--------	--------	*T. rubrum*				*Chenopodium ambrosioides* – L inhibited *T. rubrum*, diameter of inhibited zone: 8 mm	[57]
42	- *Chenopodium murale* L. - Nettle-leaf Goosefoot - Chenopodiaceae	Whole plant/Extraction and fraction	Maceration/Fractions	Methanol (Extract) D. Water (Fraction) n-hexane (Fraction) Chloroform	--------	--------	*T. longifusus* *M. canis*				The Percent of Inhibition of the Crude methanolic Extract of *Chenopodium murale* L. Against Different dermatophytes: *T. longifusus*→ 70% *M. canis*→ 30%	[58]

				(Fraction) Ethyl acetate (Fraction) n-butanol (Fraction)								
43	- *Chenopodium botrys* L. - Jerusalem Oak - Chenopodiaceae	aerial parts/essential oil	Hydro-distillation	--------	1. Oxygenated sesquiterpenes 2. Sesquiterpenes 3. Monoterpenes 4. Oxygenated monoterpenes	elemol acetate (16.3%) elemol (14.1%), botrydiol (11.1%), α-chenopodiol (9.5%), β-eudesmol (7.0%) Selina-3.11-dien-6α-ol (6.1 %) (Some of important compounds)	*T. mentagrophytes* *E. floccosum* *M. canis*	0.78 0.78 0.78 (µg/ml)	0.78 0.78 0.78 (µg/ml)	Seeded strains Without the oil	*Chenopodium botrys* L. oil showed a strong activity against the tested dermatophytes	[22]
44	- *Terminalia chebula* Retz. - Black or Chebulic myrobalan - Combretaceae	Leaf, Stem, Stem bark, Fruits/Flavonoid-rich fraction and isolated compound	Thin-layer chromatography (TLC) and Preparative TLC/Fraction	The best mobile phase: benzene, acetic acid and water (125:72:3)	Flavonoid Free Flavonoid Bound Flavonoid	apigenin	*T. mentagrophytes*	Leaf E^1:0.078 E^2: Stem E^1:0.039 E^2:0.039 Stem bark E^1:0.039 E^2: Fruits E^1:0.078 E^2:0.156 (mg/ml)	0.156 0.039 0.078 0.078 0.156 0.312 (mg/ml)		*Terminalia chebula* Retz. can be explored as an antifungal agent. E^1, Free Flavonoid; E^2, Bound Flavonoid.	[59]
45	- *Terminalia chebula* Retz. - Black or Chebulic myrobalan - Combretaceae	Dried ripe fruits/Extraction	Maceration	Ethanol (70%) Distilled water	--------	--------	*T. mentagrophytes* (aqueous) (ethanolic) *T. rubrum* (aqueous) (ethanolic)	 3.125 3.125 6.25 3.125 (µg/ml)	 12.5 6.25 12.5 6.25 (µg/ml)	3.125- 3.125-50 3.125- 3.125-50 (µg/ml) Ketoconazole, Itraconazole and Fluconazole respectively	The efficacy of lyophyilized extracts of *Terminalia chebula* Retz. was nearly equal to that of the standard antifungal drugs.	[23]

46	- *Terminalia chebula* Retz. - Black or Chebulic myrobalan - Combretaceae	Galls/Extraction	Maceration	Distilled deionized water	Polyphenols Tannins	--------	*T. mentagrophytes* *T. rubrum* *T. soudanense*		Isoconazole	Aqueous extract from galls of *Terminalia chebula* Retz. showed high inhibitory activity *T. mentagrophytes* → 1 *T. rubrum* → 2 *T. soudanense* → 3 *Evaluated on a scale of 0 (no inhibition) to 5 (strong inhibition).	[60]
47	- *Medicago sativa* L. - Alfalfa, Yellow alfalfa - Fabaceae	Roots and aerial parts/Saponin-rich fraction and isolated compounds	Soxhlet (Extraction) and the saponin-rich fraction obtained by Open Column Chromatography (C-18 silicagel)	Dichloromethane Methanol (80%) (for extraction)/ Mobile phase to obtain saponin-rich fraction (methanol (30%))	Saponin-rich fraction Individual saponins Isolated compound (aglycones and glycones)	Medicagenic acid Zanhic acid Hederagenin Soyasapogenol glucopyranoside medicagenate	*T. interdigitale* (roots) (aerial parts) *T. tonsurans* (roots) (aerial parts) *M. Gypseum* (roots) (aerial parts)	1 1 <0.0625 <0.0625 0.5 0.5 (mg/ml)	<0.0025 <0.0025 <0.0025 (mg/ml) Miconazole	*T. tonsurans* appeared to be the most sensitive against *Medicago sativa* L.	[61]
48	- *Medicago arabica* (L.) Huds. - Spotted medick, spotted burclover, heart clover - Fabaceae	Roots and aerial parts/Saponin-rich fraction and isolated compounds	Soxhlet (Extraction) and the saponin-rich fraction obtained by Open Column Chromatography (C-18 silicagel)	Dichloromethane Methanol (80%) (for extraction)/ Mobile phase to obtain saponin-rich fraction (methanol (30%))	Saponin-rich fraction Individual saponins Isolated compound (aglycones and glycones)	Hederagenin 3-O(α-L-arabinopyranoside Hederagenin 3-O-(α-L-arabinopyranoside), 28-O-(β-D-glucopyranoside) Hederagenin	*T. interdigitale* (roots) (aerial parts) *T. tonsurans* (roots) (aerial parts) *M. Gypseum* (roots) (aerial parts)	0.125 0.125 <0.0625 <0.0625 0.125 0.125 (mg/ml)	<0.0025 <0.0025 <0.0025 (mg/ml) Miconazole		[61]
49	- *Medicago hybrida* (Pourr.) Trautv. - Hybrid alfalfa - Fabaceae	Roots and aerial parts/Saponin-rich fraction and isolated compounds	Soxhlet (Extraction) and the saponin-rich fraction obtained by Open Column Chromatography (C-18 silicagel)	Dichloromethane Methanol (80%) (for extraction)/ Mobile phase to obtain saponin-rich fraction (methanol (30%))	Saponin-rich fraction Individual saponins Isolated compound (aglycones and glycones)	Medicagenic acid Hederagenin Bayogenin 3-O-(β-D-glucopyranosyl), 28-O-(β-D-glucopyranoside) Medicagenate 3-O-(β-D-glucopyranoside) Hederagenin 3-O-β-D-glucopyranosyl, 28-O-β-D-glucopyranoside Bayogenin	*T. interdigitale* (roots) (aerial parts) *T. tonsurans* (roots) (aerial parts) *M. Gypseum* (roots) (aerial parts)	0.5 2 0.25 0.5 2 2 (mg/ml)	0.0025 <0.0025 <0.0025 (mg/ml) Miconazole		[61]

50	- *Medicago murex* Willd. - Spiny medick - Fabaceae	Roots and aerial parts/Saponin-rich fraction and isolated compounds	Soxhlet (Extraction) and the saponin-rich fraction obtained by Open Column Chromatography (C-18 silicagel)	Dichloromethane Methanol (80%) (for extraction)/ Mobile phase to obtain saponin-rich fraction (methanol (30%))	Saponin-rich fraction Individual saponins Isolated compound (aglycones and glycones)	--------	*T. interdigitale* (roots) (aerial parts) *T. tonsurans* (roots) (aerial parts) *M. Gypseum* (roots) (aerial parts)	0.125 0.5 0.0625 <0.0625 0.125 0.5 (mg/ml)		<0.0025 <0.0025 <0.0025 (mg/ml) Miconazole		[61]
51	- *Nicotiana tabacum* L. - Tobacco, Cultivated tobacco - Solanaceae	Leaves/Extraction	Soxhlet/Extraction	Hot water and 95% ethanol and 95% (v/v) methanol in the ratio 2:1	1. Alkaloids 2. Carbohydrates=cyanogenic glycosides =saponines =tanines=sterols and terpenoids	Tannic acid	*E. floccosum* (hot water) (alcohol) *M. canis* (hot water) (alcohol) *T. rubrum* (hot water) (alcohol)	62.5 62.5 7.8 15.6 62.5 31.3 (mg/ml)	31.3 62.5 62.5 (mg/ml)		No fungicidal activity was recorded for any of the extracts on *E. floccosum.* Fungicidal action was observed for *M. canis* and *T. rubrum*, with hot water extract in 62.5mg/ml, whereas alcohol extracts was not affected.	[62]
52	- *Nicotiana tabacum* L. - Tobacco, Cultivated tobacco - Solanaceae	Leaves/Extraction	Maceration	Hexane Chloroform Ethyl acetate	Pyridine and pyrimidine alkaloids	acid oxalic	*T. rubrum* (hexane) (chloroform) (ethyl acetate)	0.1 0.1 2 (µg/ml)			*Nicotiana tabacum* L. extracts has shown a higher inhibitory effect at small concentration against the *T. rubrum.*	[63]
53	- *Nicotiana tabacum* L. - Tobacco, Cultivated tobacco - Solanaceae	Leaves/Extraction	Maceration	Ethanol (95%) Distilled water	Alkaloids Tannins	--------	*T. mentagrophytes* (ethanol) (aqueous) *M. canis* (ethanol) (aqueous)	> 5 > 25 5 25 (mg/ml)			Ethanol extract from *Nicotiana tabacum* L. was significantly the more effective in comparison to aqueous extract. *MGI: mycelium growth inhibition	[64]
54	- *Phyllanthus emblica* L. - Amla, Indian gooseberry - Phyllanthaceae	Fruit/Extraction	Maceration	Ethanol Distilled water	Phenol compounds Tannins	--------	*E. floccosum* *M. gypseum* *T. rubrum*	2+ 2+ 2+		50 (g/ml) Nystatin	Extracts of *Phyllanthus emblica* L. showed significant activity against all three dermatophytes. 2+: 10–15 mm diameter of zone of inhibition	[65]

55	- *Emblica officinalis* Gaertn. - Amla, Indian gooseberry - Phyllanthaceae	Fruit/ Ayurvedic preparations	Decoction	Water	--------	--------	*T. rubrum* *M. gypseum*			Sterile normal saline	Inhibition zones >10 mm indicate strong antimicrobial activity Zone of inhibition: *T. rubrum*→ 30mm *M. gypseum*→ 41mm	[66]
56	- *Emblica officinalis* Gaertn. - Amla, Indian gooseberry - Phyllanthaceae	Leaf/Extract ion	Soxhlet	Petroleum ether Chloroform Ethyl acetate Methanol Distilled water	1. Flavonoids =Alkaloids 2. Tannins 3. Saponins=phenols	--------	*T. rubrum*			Ketoconazole	The activity of the Ethyl acetate extracts was higher than solvents. Zone of Inhibition (mm) in 5 mg/ml: Petroleum Ether → 7.6+0.5 Chloroform → 5 Ethyl acetate → 12.6+0.5 Methanol → 6.3+1.1 Aqueous → 5.6+0.5 Ketoconazole → 17.6+1.1	[67]
57	- *Emblica officinalis* Gaertn. - Amla, Indian gooseberry - Phyllanthaceae	Leaf/Extract ion	Soxhlet	Petroleum ether Chloroform Ethyl acetate Methanol Distilled water	--------	--------	*T. tonsurans*				The activities of the methanol and Ethyl acetate solvent extracts were higher Zone of Inhibition (mm) in 5 mg/ml: Pet ether → 4.3+1.5 Chloroform → 8.6+1.5 Ethyl acetate → 11 Methanol → 9.6+ 0.5 Aqueous → NA Ketoconazole → 28.6+1.1	[68]
58	- *Lavandula luisieri* (Rozeira) Rivas Mart. - Lavender - Lamiaceae	Aerial parts (of two samples of *L. luisieri* in the center (Piódão region) and South (Cabo São Vicente region) of Portugal/Essential oil	Hydro-distillation	--------	Oxygenated monoterpenes irregular monoterpenes	3,4,4-trimethyl-2-cyclohexanone a-trans necrodol 1,1,2,3-tetramethyl-4-hidroximethyl-2-cyclopentene 2, 3,4,4-tetramethyl-5-methylene-cyclopenten-1-one a-trans-necrodyl acetate a-cis-necrodyl acetate (Some of important compounds) Significant quantitative differences were found between both samples concerning the amounts of the three main constituents: 1,8-cineole, Fenchone and trans-a-necrodyl	*E. floccosum* *L. luisieri* A / B *M. canis* *L. luisieri* A/B *M. Gypseum* *L. luisieri* A/B *T. mentagrophytes* *L. luisieri* A/B *T. mentagrophytes* (var. *interdigitale)* *L. luisieri* A/B	0.16/ 0.32 0.16- 0.32/ 0.64 0.32/ 0.64 0.32/ 0.64 0.16- 0.32/ 0.64	0.16 / 0.32- 0.64 0.16- 0.32/ 0.64 0.32- 0.64/ 0.64- 1.25 0.32- 0.64/ 0.64 0.64/ 0.64 - 1.25	16 128 128 16-32 128	The use of *Lavandula luisieri* essential oils emphasize antifungal properties at concentrations not cytotoxic or with very low side effects on mammalian cells.	[69]

						Acetate		0.64			
							T. rubrum			16	
							L. luisieri A/B	0.16/ 0.32	0.32/0.32-0.64		
							T. verrucosum			> 128	
							L. luisieri A/B	0.32/ 0.32 (µl/ ml)	0.32-0.64/ 0.32-0.64 (µl/ ml)	(µg/ml) Fluconazole	
59	- *Lavandula multifida* Burm.f. - Egyptian lavender, fernleaf lavender - Lamiaceae	Aerial parts/Phenolic rich essential oil and two isolated compounds	Hydro-distillation/Purchased compounds including: Carvacrol and cis-β-ocimene	----------	Phenolic compounds Oxygen-containing monoterpenes Sesquiterpene hydrocarbons Oxygen-containing sesquiterpenes	Carvacrol cis-β-ocimene myrcene β-bisabolene (E,E)-α-farnesene Terpinolene (Some of important compounds)	*T. mentagrophytes* *T. mentagrophytes (*var. *interdigitale)* *T. rubrum* *T. verrucosum* *M. canis* *M. Gypseum* *E. floccosum*	0.16 0.16 0.16 0.16 0.16 0.16 0.16 (µl/ ml)	0.32 0.32 0.32 0.32 0.32 0.32 0.32 (µl/ ml)	16–32 128 16 >128 128 128 16 (µg/ml) Fluconazole	The antifungal activity of *Lavandula multifida* essential oil is mainly due to the presence of carvacrol	[70]
60	- *Lavandula viridis* L'Hér. - Yellow lavender - Lamiaceae	Aerial parts/Essential oil and four isolated compounds	Hydro-distillation/ Purchased compounds including: 1,8-cineole, Camphor, α-pinene and linalool	--------	Oxygen-containing monoterpenes Monoterpene hydrocarbons Sesquiterpenic compounds	1,8-cineole Camphor α-pinene linalool (Some of important compounds)	*T. mentagrophytes* *T. mentagrophytes (*var. *interdigitale)* *T. rubrum* *T. verrucosum* *M. canis* *M. Gypseum* *E. floccosum*	0.32–0.64 0.32–0.64 0.32 0.32 0.32 0.64 0.32 (µl/ ml)	0.64 0.64 0.32 0.32–0.64 0.32 0.64 0.32 (µl/ ml)	16–32 128 16 >128 128 128 16 (µg/ml) Fluconazole	The results show that *Lavandula viridis* essential oils may be useful in the clinical treatment of Dermatophytosis. α-pinene proved to be a very active compound	[71]
61	- *Lavandula stoechas* L. - French Lavender - Lamiaceae	Aerial parts/Essential oil and two isolated compounds	Hydro-distillation/ Purchased compounds including: Fenchone and Camphore	--------	Oxygenated monoterpenes Phenolic compounds	Fenchone Camphor bornyl acetate 1,8-cineole Thymol Carvacrol (Some of important compounds)	*E. floccosum* *M. canis* *M. gypseum* *T. mentagrophytes* *T. mentagrophytes (*var. *interdigitale)* *T. rubrum* *T. verrucosum*	0.32 0.64 0.64 0.64 0.64 0.64 0.64 (µl/ ml)	0.64 0.64 0.64–1.25 0.64 1.25 1.25 0.64 (µl/ ml)	16 128 128 16–32 128 16 >128 (µl/ ml) Fluconazole	Synergistic effect of several major compounds such as, fenchone and camphor, tested alone and showed very low antifungal activity.	[72]

62	- *Lavandula latifolia* Medik. - Broadleaved lavender, Spike Lavender - Lamiaceae	Flowering tops/Essential oil	Not mentioned	--------	Terpenoids	--------	*E. floccosum* *T. mentagrophytes* var. *interdigitale* *T. rubrum*			*T. mentagrophytes* var. *interdigitale* seemed to be less susceptible to the Oil *maximum inhibitory dilution (MID): *E. floccosum* → 1:3,2oo-I: 1,6oo(vol/vol) *T. mentagrophytes* var. interdigitale → > 1:8oo (vol/vol). *T. rubrum* → 1:3,2oo-I: 1,6oo (vol/vol)	[73]
63	- *Lavandula officinalis* Chaix - English lavender - Lamiaceae	Flowering tops /Essential oil	Not mentioned	--------	Terpenoids	--------	*E. floccosum* *T. mentagrophytes* var. *interdigitale* *T. rubrum*			*T. mentagrophytes* var. *interdigitale* seemed to be less susceptible to the Oil *maximum inhibitory dilution (MID): *E. floccosum* → < 1:3,200(vol/vol) *T. mentagrophytes* var. interdigitale → 1:3,2oo-I: 1,6oo (vol/vol) *T. rubrum* → < 1:3,200 (vol/vol)	[73]
64	- *Ipomoea aquatic*a Forsk. - water spinach, river spinach - Convolvulaceae	Fresh Apical buds, dry Apical buds, fresh flowers and dry flowers/Extraction	Maceration	Ethanol (95%)	Phenolic compounds	3,5-di-Ocaffeoyl-quinic acid (or isochlorogenic acid)	*T. rubrum* (fresh Apical buds) (dry Apical buds) (fresh flowers) (dry flowers) *E. floccosum* (fresh Apical buds) (dry Apical buds) (fresh flowers) (dry flowers) *M. gypseum* (fresh Apical buds) (dry Apical buds) (fresh flowers) (dry flowers)	25 50 25 25 50 25 50 50 50 (mg/ml)	10 (mcg/ml) Miconazole	The extracts of dry apical buds and dry flowers of *Ipomoea aquatic* Forsk had the highest antifungal activity by disc diffusion test, But the fresh flower extract could inhibit only *E. floccosum*.	[74]

65	- *Ipomoea aquatica* Forsk. - Water spinach, river spinach - Convolvulaceae	Stems/Extraction	Maceration	Ethanol (99.5%)	Alkaloids Saponin Flavonoids, Carbohydrates Glycosides Steroids Proteins (Amino acids) Tannins	--------	*T. rubrum*		Fluconazole	The extract of stems showed antifungal activity against *T. rubrum.* organisms. Zone of Inhibition (mm): Plant extract (100 µl) = 15.12mm Fluconazole (20 µl) =30.10mm	[75]
66	- *Ipomoea pes-caprae* (L.) R. Br. - Beach morning glory - Convolvulaceae	roots and stem/Extraction	soxhlet	Methanol, chloroform, ethyl acetate and hexane	Ergoline alkaloids Indolizidine alkaloids Nortropane alkaloids Phenolics compounds Coumarins Diterpene Isocoumarin Benzenoids Flavonoids Antocianosides Glycolipids Lignin Triterpenes	--------	*M. gypseum* *T. mentagrophytes*		Nystatin	*M.gypseum* and *T. mentagrophyte* were susceptible to the methanol extract of ste of *Ipomoea pes-caprae* (L.) R. Br. Zone of Inhibition: *M. gypseum* → 6 (mm) *T. mentagrophytes* → 3 (mm)	[76]
67	- *Ipomoea batatas* (L.) Lam. - Sweet potato - Convolvulaceae	Peels/Three isolated compounds from n-hexane fraction	Three isolated compounds	n-hexane (The solvent for this fraction)	Triterpenoids Steroid	Stigmasterol 3-friedelanol Urs-13(18)-ene-3β-yl acetate	*T. mentagrophytes*	50 (µg/ml)		Peels which are generated as waste from sweet potato can be used to ameliorate skin infections	[77]
68	- *Ipomoea congesta* R. Br. - Ocean blue morning-glory - Convolvulaceae	Seed/Extraction	Soxhlet	Acetonitrile	--------	--------	*M. canis* *E. floccosum* *T. rubrum*	1000 1000 (µg/ml)	12.5 3.25 6.25 (µg/ml) Nystatin	*Ipomoea congesta* R. Br. extract showed antifungal activity to a lesser extent.	[78]

69	- *Nigella sativa* L. - Black cumin - Ranunculaceae	Aerial parts/Essential oil	Hydro-distillation	--------	Terpenoids	p-Cymene, Thymol (Major compounds)	*T. mentagrophytes* *T. rubrum* *E. floccosum* *M. gypseum* *M. canis*	2 ± 0.6 4 ± 1.1 2 ± 0.6 2 ± 0.6 4 ± 1.1 (mg/ml)	4 ± 1.1 4 ± 1.1 4 ± 1.1 4 ± 1.1 8 ± 2.8 (mg/ml)	2 ± 0.6 4 ± 1.1 4 ± 1.1 0.25 ± 0.1 0.5± 0.2 (mg/ml) Fluconazole	100% of the dermatophytes were inhibited at 4 mg/ml.	[48]
70	- *Nigella sativa* L. - Black Cumin - Ranunculaceae	Seed/Extraction	Maceration	Ether	Terpenoids	Thymoquinone Thymohydroquinone Dithymoquinone Thymol Carvacrol Nigellicine Nigellimine-N-oxide Nigellidine α-hedrin	*T. rubrum*$_1$ *T. rubrum*$_2$ *T. rubrum*$_3$ *T. rubrum*$_4$ *T. mentagrophytes* *T. interdigitale* *E. floccosum* *M. canis*	40 40 40 40 40 40 40 10 (mg/ml)		0.0155 0.0077 0.0077 0.0077 0.0077 0.0155 0.0038 0.00095 (mg/ml) Griseofulvin	The results denote the potentiality of *Nigella sativa* L. as a source for anti-dermatophyte drugs and support its use in folk medicine for the treatment of dermatophytosis.	[79]
71	- *Nigella sativa* L. - Black Cumin - Ranunculaceae	Seeds/Essential oil, extraction and isolated compound	Steam-distillation Maceration Purchased Thymoquinone	-------- Methanol (80%) Distilled water	Terpenoids	Thymoquinone p-cymene Carvacrol Longifolene 4-terpineol (as main components of essential oil)	*T. mentagrophytes* (essential oil) (Methanol) (Aqueous) (Thymoquinone) *M. canis* (essential oil) (Methanol) (Aqueous) (Thymoquinone) *M. gypseum* (essential oil) (Methanol) (Aqueous) (Thymoquinone)	4 8 16 0.125 4 4 8 0.062 4 8 16 0.125 (mg/ml)		0.25 0.125 0.250 (mg/ml) Fluconazole	The results revealed that the essential oil and various extracts of *Nigella sativa* L. specially thymoquinone have potent antifungal effects.	[80]
72	- *Nigella sativa* L. - Black Cumin - Ranunculaceae	Seed grains/Extraction of Protein	Shewry method	Not mentioned	proteins	Phenylalanine Tyrosine Glutamic acid (Main amino acids)	*M. canis* *M. gypseum* *T. mentagrophytes* *T. verrucosum*				*Nigella sativa* L. revealed the highest antifungal activity (5.3 cm) on *M. canis.* Diameters of inhibition zones (cm): *M. canis* →5.3 *M. gypseum* → 3.8 *T. mentagrophytes* → 1.8 *T. verrucosum* → 2.2	[81]
73	- *Nigella sativa* L. - Black Cumin - Ranunculaceae	Seed/Isolated compound	--------	--------	Terpenoids	Tymoquinone	*T. mentagrophytes* (var *interdigitale)*			Clotrimazole	Thymoquinone inhibits the germination of dermatophyte arthrospores. Effect of *Nigella sativa* L. on the germination (%): Thymoquinone: (0.128 mg/ml) →5.22 + 1.68 (0.064 mg/ml) → 10.9 + 4.01	[82]

											(0.032 mg/ml) → 42.22 + 9.47 Clotrimazole: (0.064 mg/ml) → 12.8 + 3.48	
74	- *Nigella sativa* L. - Black Cumin - Ranunculaceae	Seeds/Purchased oil	--------	--------	Fixed oil	--------	*T. violaceum* *M. canis* *T. mentagrophytes* *T. rubrum*			Fluconazole Standard	Percent of sensitivity of dermatophyte isolates to *Nigella sativa* L. *T. violaceum* → 25% *M. canis* → 78.6% *T. mentagrophytes* → 100% *T. rubrum* → 66.6%	[83]
75	- *Nigella sativa* L. - Black Cumin - Ranunculaceae	Seeds/Essential oil	Hydro-distillation	--------	Terpenoids	para-cymene α-thujene Dihydrocarveol Longifolene β-pinene (as main compounds)	*M. gypseum* *T. rubrum* *T. simii*	<0.1 <0.1 <0.1 (µl/ml)		Ketoconazole	Inhibition zones(mm) for *Nigella sativa* L.: *M. gypseum* →38 ± 1.52 *T. rubrum* →20 ± 1.73 *T. simii* → 35 ± 1.15 For ketoconazole: *M. gypseum* →20 ± 1.73 *T. rubrum* →15 ± 1.15 *T. simii* → 32 ± 0.57	[84]
76	- *Camellia sinensis* (L.) Kuntze - Tea plant, tea shrub - Theaceae	Leaves/Extraction	Maceration	Acetone Water	Catechins, Phytosterols Tannins Flavonoids	--------	*M. persicolor* (acetone) (water)	0.020 ± 0.005 0.180 ± 0.010 (mg/ml)		0.060 ± 0.000 (mg/ml) Griseofulvin	The results revealed that the acetone crude extract had the most important in-vitro activity against *M. persicolor*.	[85]
77	- *Camellia sinensis* (L.) Kuntze - Green tea - Theaceae	Leaves/Extraction	Maceration Soxhlet Maceration	Ethanol (70%) Ethanol (70%) Distilled water	Polyphenols Cathechine	(-)-epigallocatechin-3-gallate (-)-epigallocatechin (-)-epicatechin 3-gallate (-)-epicatechin	*T. mentagrophytes* *T. verrucosum* *T. rubrum*			Clotrimazole	The cold ethanol extract of *Camellia sinensis* showed the best antifungal activity against isolates.	[86]
78	- *Camellia sinensis* (L.) Kuntze - Tea plant, tea shrub - Theaceae	Leaves/Extraction	Soxhlet	Methanol	--------	--------	*T. mentagrophytes* *E. floccosum*	100±0.5 100±0.5 (mg/ml)	0.01 /100ml 0.01 /100ml	10 10 (µg/ml) Fluconazole		[87]

79	- *Quercus infectoria* G. Olivier. - Aleppo Oak, Oak - Fagaceae	Fruit/Extraction	Maceration	Distilled water Ethanol (95%) Acetone/water (7:3)	Glycosides Tannins Saponins Flavonoids Carbohydrates Phenols Fuocoumarins Coumarins Volatile oils		*T. mentagrophytes* var. *mentagrophytes* *T. mentagrophytes* (var. *interdigitale)* *T. verrucosum* *T. rubrum*	7 7 5 6 (mg/ml)	Clotrimazole	A prepared ointment from phenols extracted of *Quercus infectoria* G. in the recovery period in mice infected by *T. mentagrophytes* was 13 days in compared with the recovery period of 16 days by using Clotrimazole.	[88]
80	- *Quercus infectoria* G. Olivier. - Aleppo Oak, Oak - Fagaceae	Galls/Extraction	Maceration	Distilled water Ethanol (95%)	Tannins Glycosides Volatile oils	Syringic acid Gallic acid Ellagic acid, methylolenatebeta Sitosterol, Amentoflavone Hexamethyl ether, Isocryptomerin, methyl betulate Hexagalloyl glucose	*M. gypseum* *T. rubrum*			The resalts indicated that the ethanolic extract of *Quercus infectoria* G. has more effects as antifungal on the growth of dermatophytes than opportunistic fungi. Inhibition diameter (mm): Aqueous extract in 5mg/ml: *M. gypseum* →1.25 ± 0.0055 *T. rubrum* → 0 Ethanol extract *M. gypseum* →1.25 ± 0.0143 *T. rubrum* →1.50 ± 0.0073	[89]
81	- *Quercus infectoria* G. Olivier. - Aleppo Oak, Oak - Fagaceae	Galls/Extraction and tannins-rich fractions via two methods	Maceration (for extraction) and chromatography on Sephadex LH-20 and TLC (to prepare tannins-rich fractions)	Acetone/water (7:3) Ethanol (95%) (to prepare extractions)	Tannins	--------	*T. mentagrophytes*		Clotrimazole	Acetonic galls extract revealed highest inhibition percentage (100%) in all concentrations used in comparison with Clotrimazole.	[90]

M. canis: Microsporum canis, M. gypseum: Microsporum gypseum, T. rubrum: Trichophyton rubrum, T. schoenleinii: Trichophyton schoenleinii, T. mentagrophytes: Trichophyton mentagrophytes, E. floccosum: Epidermophyton floccosum, T. erinacei: Trichophyton erinacei, T. soudanense: Trichophyton erinacei, T. tonsurans: Trichophyton tonsurans, M. audouinii: Microsporum audouinii, T. violaceum: Trichophyton violaceum, T. verrucosum: Trichophyton verrucosum, T. longifusus: Trichophyton longifusus, M. fulvum: Microsporum fulvum, M. ferrugineum: Microsporum ferrugineum, T. terrestre: Trichophyton terrestre,

Table 2: *In-vivo* antifungal activity

No	Scientific Name	Method of extraction/ Solvent	Formulation	Treatment Groups (Animal Model)	Administration Of Treatment	Clinical Study Recovered/Slight Improvement	Dermatophyte Sp.	Ref.
1	*Lawsonia inermis* L.	Maceration (Water)	Henna paste	Goats	Pasty texture. Twice daily.	Disappearance of lesion and complete regrowth of the hair was observed at 30 days after treatment.	*M. canis* *T. mentagrophytes T. rubrum* *T. tonsurans*	91
2	*Myrtus communis* L.	Maceration (Methanol)	Ointment, gel and solution with Concentration of 1%, 2% and 5% of extraction	Guinea Pigs	Topical application. Once a day.	No ointment concentration showed inhibition effect on pigs infected by *M. canis* but inhibition via 2% extraction liquid and 2-5% gel was considerable. There weren't any considerable differences using all concentration between *M. gypseum and T. mentagrophytes* but the highest efficacy of *Myrtus communis* L. was observed in *T. mentagrophytes* pig models compared to clotrimazole.	*M. gypseum* *M. canis* *T. mentagrophytes* (var. *interdigitale)*	92
3	*Myrtus communis* L.	Percolation (methanol (80%))	Don't mentioned the dosage form	Guinea Pigs	Topical application. Once a day.	*M. Communis* with the concentration of 1 g/kg BW resulted in the complete cure of *T. mentagrophytes* and *M. canis* infection on days 11 and 13, respectively; while the concentration of 2 g/kg BW significantly ($p < 0.05$) cured *T. mentagrophytes* and *M. canis* infection on days 9 and 13, respectively.	*T. mentagrophytes* *T. interdigitale* *M. canis* *M. gypseum*	93
4	*Rosmarinus officinalis* L.	Essential oil	Don't mentioned the dosage form	Rats	Sterile tissue. Daily for five days.	Our results clearly showed that the hairs of 56 rats making up our work lot were free from any contamination by dermatophytes. However, mycological analysis of rat hair revealed the isolation of several saprophytic mold species.	*T. rubrum* *M. canis* *E. floccosum* *T. mentagrophytes*	94
5	1- *Origanum vulgare* L. 2- *Rosmarinus officinalis* L. 3-*Thymus serpillum* L.	Essential oil	Topical oil contained: 5% of *O. Vulgare*, 5% of *R. officinalis* and 2% of *T. serpillum* mixed in sweet almond oil	Cats	Topical application. For a month.	Five out of seven cats treated with essentials oil recovered clinically, four of them showed negative cultures, while two animals healed partially still yielding positive cultures	*M. canis*	46
6	1- *Origanum vulgare* L. 2- *Rosmarinus officinalis* L. 3-*Thymus serpillum* L.	Essential Oil	Topical oil contained: *O. vulgare* (5%) *R.Officinalis* (5%) *T. serpillum* (2%) in sweet almond oil	Sheeps	Topical application. Twice daily for 15 days.	*Thymus serpillum* L. and *Origanum vulgare* L. showed the lowest minimum inhibitory concentrations (MICs), which were active at 0.1% and at 0.5%, respectively, followed by *I. verum* (2.5%), whereas *R. officinalis* and *C. limon* showed MIC at 5%. The overall MIC value of the mixture of *T. serpillum* (2%), O. vulgare (5%) and *R. officinalis* (5%) was 20%. The MIC for enilconazole was 0.1%.	*T. mentagrophytes* (var. *mentagrophytes)*	95

7	*Urtica dioica* L.	Maceration (Methanol (70%))	Don't mention the dosage form 10, 20 and 30% of methanol extract used as active ingredient	Guinea pigs	Topical application. Once a day for 1 Week.	On the day 15 post inoculation, the clinical efficacy of used formulations resulted in 0, 5, 5, 0, and 10 % for *Urtica dioica* L. 10%, 20%, 30%, DMSO, and positive control groups, respectively. However, on the day 30 post inoculation, the clinical efficacy of used formulations increased to 11.76, 23.52, 76.47, 5.88 ,and 94.11 % for *Urtica dioica* L. 10%, 20%, 30%, DMSO, and positive control groups, respectively. Only *Urtica dioica* L. 30% and positive control groups showed clinical effectiveness against dermatophytosis.	*M. canis*	96
8	*Chenopodium ambrosioides* L. (Separate and Mix with *Cymbopogon martini* (Roxb.) W. Watson)	Essential oil	Topical ointment Contained: each essential oil and their combination was prepared by mixing 1 ml of the oil with 100 g petroleum jelly	Guinea pigs	Topical application. Twice daily for 15 days.	*Chenopodium ambrosioides* L. resulted in the complete cure of *T. rubrum* and *M. gypseum* infection at day 17 and day 21.	*M. gypseum* *T. rubrum*	56
9	*Terminalia chebula* Retz.	Flavonoid fraction	Topical ointment prepared by mixing 25 and 50 mg of test extract in 10 g inert petroleum jelly to make 2.5 and 5 mg/g concentrations of test extract	Mice	Topical application. Twice daily for 8 days.	Complete recovery from the infection was recorded on 12th day of treatment for 5 mg/g concentration of ointment, whereas 2.5 mg/g ointment showed complete cure on 16th day of treatment	*T. mentagrophytes*	59
10	*Nigella sativa* L.	Fixed oil	Topical oil Contained: Fixed oil of seeds	Cattle	Groups 1, 2 and 3 were treated as follows: enilconazole (three times at 3day intervals), *Nigella sativa* L. (once a day for two weeks)	Clinical signs healed completely after 42 days in six animals in group 1 and in five animals in group 2 and in all animals in group 3 *Nigella sativa* L. application alone cured five of eight animals in group 2 and *Nigella sativa* L. in combination with enilconazole resulted in complete recovery in all animals in group 3.	*T. verrucosum*	97
11	*Camellia sinensis* (L.) Kuntze	Maceration (Solvents: acetone/water (7:3) and distilled water	Orally administration Dosing: 20 mg/mouse/day diluted into 250 mL of distilled sterile water.	Mice	Intravenous. During 5 days.	The mycosis caused by *M. persicolor* was treated with the administration of 80mg of the acetone crude extract after 4 days of treatment. But the aqueous crude extract was less active.	*M. persicolor*	85
12	*Quercus infectoria* G. Olivier	Phenol-rich fraction	Topical ointment Prepared from phenol-rich fraction	Rats	Topical application.	Duration of improvement with tannis extract of *Quercus infectoria* G. was 14 days.	*T. mentagrophytes*	88

PC: Positive Control, NC: negative control, *T. verrucosum: Trichophyton verrucosum, M. canis: Microsporum canis, T. rubrum: Trichophyton rubrum, T. mentagrophytes: Trichophyton mentagrophytes, T. tonsurans: Trichophyton tonsurans, M. gypseum: Microsporum gypseum, T. interdigitale: Trichophyton interdigitale, M. persicolor*

Conclusion

It should be underlined that most of the herbal species, claimed for potent antifungal activity, have not been studied in-vivo trials. Also, the spectrum of activity, the active ingredients in herbal species and mechanisms of action remain unknown in in-vitro and in-vivo. Therefore, this result should motivate studies on side-effects, and on the progressed formulations for clinical application. Randomized clinical trials (RCT) should be performed and compared to the common treatment regimens of dermatophytosis.

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Conflict of interest

The authors further declare that, they have no conflict of interest.

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