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Inhibitory Potential of Essential Oils on *Malassezia strains* by Various Plants †

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Abstract: There are imperative to opportunistic skin pathogens and skin commensals for *Malassezia* genus of the yeasts in lipophilic. Recently, in the eastern and western US nine types of bats skins were isolated as new *Malassezia* species in the subfamily *Myotinae*. Factually, wild-type *Malassezia* insulates typically susceptible to azoles, except for fluconazole, but developed azole resistance in the area of these strains has lately been related to either alterations or quadruplication on the *ERG11* gene. Those remarks are provoked for interest in substitute antifungal therapy, like chlorhexidine, and different plant essential oils. The purposes of this investigation were to assess atopic dermatitis (AD) along with the *Malassezia* species and the adequacy of its inhibitory by different plants essential oils against pathogenic *Malassezia* isolates. Plants produce essential oils because of physiological stresses, microorganism assaults, and biological variables. 'Essential oils are complex volatile compounds, integrated normally in various plant parts during the cycle of secondary metabolism. The yeasts of the class Malassezia have been related with various ailments influencing the human skin, for example, psoriasis, atopic dermatitis, dandruff, seborrheic dermatitis, folliculitis, *Malassezia* (*Pityrosporum*) and pityriasis Versicolor, and—less generally—with other dermatologic issues, for example, transient acantholytic dermatosis, onychomycosis, and reticulated and confluent papillomatosis. *Malassezia* is a significant causal factor for seborrheic dermatitis. Studies looking at cell and humoral immune responses explicit to *Malassezia* species in patients with *Malassezia*-related infections and healthy controls have commonly been not able to characterize critical contrasts in their resistant reaction. These days, the medications accessible to treat this fungal infection are not many. The current examination was expected to for clinical utilization of essential oils and there is an urgent need to direct further in vivo investigations with a huge number of patients' so as to confirm the clinical capability of essential oils against *Malassezia* species.

Keywords: *Malassezia strains*; phytochemicals; essential oils; antifungal activity; dermatitis; atopic derrmatits; pityriasis Versicolor; dandruff

1. Introduction

Malassezia class incorporates a cluster of lipophilic and typically lipid-subordinate yeasts perceived as individuals from the ordinary skin microbiome of both human and other homoeothermic life forms [1]. Malassezia is an unscrupulous species and when certain conditions they may also cause folliculitis, and *Pityriasis (P) versicolor*, can be related with exacerbate numerous dermal infections like atopic dermatitis [2–4]. 'In *P. versicolor*, *Malassezia* can multiply abundantly under favorable environmental conditions such as enhanced heat or humidity [5]. Typically, these Malassezia-related fungal infections are treated with topical therapies [6]. Polyenes and azoles like ketoconazole, itraconazole, and posaconazole are most often used against Malassezia-related fungal infections [7,8]. The therapy of this fungal infections differs on depending the severity of infection, and lesions. Regularly, includes systemic/topical imidazole derivatives. From these topical therapy fungicidal shampoos are applied once daily up to 4 weeks commonly suggest for the treatment for *P. versicolor*. Wide spread of *P. versicolor* infection can be treated with various oral antifungals like fluconazole, and itraconazole are administered at different doses up to 7–28 days [9,10]. Though, the development of fungal strains resistant to the existing antifungals in the market exposed that the progress in novel antifungals′ is essential approach to overwhelmed problems come across in treating this infection [11].

In the present review the possible use of essential oils against ′*Malassezia*-related fungal infections has been studied to indication on their possible effectiveness. Essential oils are being used from thousands of years in different fields includes health purposes, and medical uses too in ancient cultures of India, Greece, China, Egypt, and Middle East [12,13]. Numerous essential oils, outstanding usages like antimicrobial activities, having varied applications, includes raw and processed food preservations and health and medical applications. Studies have reveled that essential oils effectively exterminate numerous viral; fungi and bacterial pathogens includes *Candida albicans* and methicillin-resistant *Staphylococcus aureus.* The extensive variety of biochemical compounds presents in essential oils leads to antimicrobial activity impute to the mixture of various biological actions on dissimilar parts on cell wall of microbe, possibly this is the reason why microorganisms didn't develop resistance [14,15]. Therefore, essential oils might be the thought-provoking choice for replacing the conventional antimicrobials and also reduce the potential risk and toxicity and may enhances the activity′ [16–19].

2. Materials and Methods

Data on inhibitory potential of essential oils′ from various plants against *Malassezia* species was collected from online data bases such as Science Direct, Scopus, PubMed, Taylor, Web of Science, Google Scholar published materials, including E-books. Covering the period from January 2008 and November 2020. Titles and abstracts were scrutinized for suitability, and any English language research article evaluating the efficiency of essential oils′ against *Malassezia spp.* was provisionally accepted.

3. Results and Discussion

Authors reported various essential oils′ against Malassezia spp. with evaluating dissimilar assays to antifungal properties. The most used assay is Broth microdilution, followed by the vapor phase method and agar disk diffusion tests. Various Malassezia spp. most often implicated in human pathologies were comprised in this study, their origin was either from laboratory collection or clinical isolation from humans and animals. All the authors stated in tables with their antifungal activity of various essential oils and also their MIC (μg/mL) values against various Malassezia spp. positively linked to dandruff and seborrheic dermal infection nonetheless evaluating tests are carried out with different Malassezia species concerned with dermal infections, in specifically *M. obtusa*, *M. globosa*, *M. sympodialis*, and *M. slooffiae*. The collected literature from preceding twelve years has revealed inordinate diversity of essential oils originating from diverse medicinal plants Artemisia, Myrtus, Thapsia, Syzigium, Rosmarinus, Ocimum, Cinnamomun, Malaleuca, Thymus, Zataria, Origanum, Foenicolum, Tachyspermum. In order to comparing the activity of essential oil against Malassezia species using the broth microdilution method, the MIC standards in μg/mL or μL/mL are stated in Table 1. Whereas in Table 2 there are those expressed by inhibition zones (mm) or $\mu L/cm^3$ from activity of some essential oils′ obtained from steam distillation and verified by different methods: disk diffusion (a), vapour phase (b).

Table 1. ′Activity of EOs against *Malassezia* species using the broth microdilution method, the MIC standards in μg/mL or μL/mL′.

'Sl.no	**Source**	**Main Constituents**	***Malassezia species***	**MIC**	**Assay**	**Reference**
1	*Cinnamomun zeylanicum* Blume	cinnamaldehyde, eugenol	*M. furfur*	32 µg/mL	Broth microdilution method	[20]
2	*Ocimum kilimandscharicum* Gürke	camphor, limonene, camphene	*M. furfur*	128 µg/mL		
3	*Malaleuca leucadendrun* (L.) L.	1,8 cineole, p-cymene, linalool	*M. furfur*	64 µg/mL		
4	*Malaleuca alternifolia* (Maiden & Betche) Cheel	not specified	*M. furfur*	32 µg/mL		
5	*Zataria multiflora* Boiss.	thymol, carvacrol	*M. furfur* *M. sympodialis* *M. slooffiae* *M. globosa* *M. obtusa* *M. nana* *M. restricta*	35 µg/mL 30 µg/mL 80 µg/mL 50 µg/mL 60 µg/mL 30 µg/mL 40 µg/mL		
6	*Thymus kotschyanus* Boiss.	thymol, carvacrol	*M. furfur* *M. sympodialis* *M. slooffiae* *M. globosa* *M. obtusa* *M. nana* *M. restricta*	60 µg/mL 60 µg/mL 80 µg/mL 80 µg/mL 80 µg/mL 30 µg/mL 110 µg/mL		[21]
7	*Mentha spicata* L.	carvone, limonene	*M. furfur* *M. sympodialis* *M. slooffiae* *M. globosa* *M. obtusa* *M. nana* *M. restricta*	125 µg/mL 100 µg/mL 100 µg/mL 250 µg/mL 85 µg/mL 65 µg/mL 85µg/mL		
8	*Artemisia sieberi* Besser	α thujone, β thujone	*M. furfur* *M. sympodialis* *M. slooffiae* *M. globosa* *M. obtusa* *M. nana*	250 µg/mL 85 µg/mL 150 µg/mL 50 µg/mL 155 µg/mL 110 µg/mL'		
9	'*Salvia rosmarinus* Schleid	α pinene, 1,8 cineole linalool	*M. furfur* *M. slooffiae* *M. sympodialis* *M. obtuse* *M. globose* *M. nana* *M. restricta*	260 µg/mL 250µg/mL 420 µg/mL 410 µg/mL 850µg/mL 100 µg/mL 350 µg/mL		
10	*Syzygium aromaticum* (L.) Merrill & Perry	eugenol and β caryophillene	*M. furfur*	0.625 µL/mL	Broth microdilution method	[22]
11	*Foeniculum vulgare* Mill	not specified	*M. furfur*	1.250 µL/mL		

12	*Trachyspermum ammi* L.	not specified	*M. furfur*	0.312 µL/mL	
13	*Thapsia villosa* L.	limonene, methyleugenol	*M. furfur*	2.5 µL/mL	[23]
14	*Deverra tortuosa subsp. arabica* Chrtek, Osbornová & Kourková flowers	apiol	*M. furfur*	5.00 µL/mL	[24]
15	*Deverra tortuosa subsp. arabica* Chrtek, Osbornová & Kourková stem	apiol	*M. furfur*	8.00 µL/mL	
16	*Myrtus communis* L.*	geranyl acetate, or 1,8 cineole	*M. furfur* *M. sympodialis* *M. slooffiae* *M. globosa* *M. obtusa* *M. japonica* *M. restricta*	31.25 µL/mL 62.5 µL/mL 31.25 µL/mL 31.25 µL/mL 62.5 µL/mL 31.25 µL/mL 125,0 µL/mL	[25]
17	*Artemisia annua* L.	camphor, 1,8 cineole artemisia ketone	*M. furfur* *M. sympodialis* *M.slooffiae* *M. globosa*	1.3 µL/mL 1.1 µL/mL 0.52 µL/mL 0.392 µL/mL	[26]
18	*Origanum vulgare* L.	thymol, *α* terpinene, *α* cymene	*M. furfur*	780 µg/mL	[27]'
19	*Thymus vulgaris* L.	*α* cymene, thymol	*M. furfur*	920 µg/mL	

Table 2. Activity of some EOs obtained by steam distillation and tested by different methods: Disk diffusion (1-9), Vapour phase (10).

Sl.no	**Essential Oils**	**Active Compounds**	***Malassezia species***	**Results**	**Assay Method**	**References**
1	*'Cinnamomun zeylanicum* Blume	cinnamaldehyde, eugenol	M. furfur	14 +/-0. 51 mm	Disk Diffusion method	[28]
2	*Ocimum kilimandscharicum* Gürke	champhor, limonene, camphene	M. furfur	8 +/- 0.057 mm		
3	*Eucalyptus globulus* Labill.	cineol, p-cymene	M. furfur	0mm		

4	*Malaleuca leucadendrun* (L.) L.	1,8 cineole p-cymene, linalool	M. furfur	12 +/- 0 mm		
5	*Malaleuca alternifolia* (Maiden & Betche) Cheel	not specified	M. furfur	22 +/- 0.057 mm		
6	*Pongamia glabra* Vent.	karanjin, pongapin, pongaglabrone	M. furfur	0 mm		
7	*Lavandula stoechas* L.	fenchone, camphor,	*M.furfur*	46.7 +/-8.2 mm		[29]
		1,8 cineole	*M.globosa*	50 +/- 0 mm		
			M.obtusa	43.7 +/- 12.5 mm		
8	*Cuminum cyminum* L.	α pinene, 1,8 cineole	*M.furfur*	50 +/- 0 mm		
		linalool	*M.globosa*	50 +/- 0 mm		
			M.obtusa	50 +/- 0 mm		
9	*Artemisia sieberi* Besser	α thujone, camphor	*M.furfur*	43.3 +/- 14.1 mm		
		β thujone	*M.globosa*	35 +/- 14.1mm		
			M.obtusa	32.5 +/- 11.9 mm		
10	*Artemisia annua* L.	Volatile emissions: α pinene 1,8 cineole, camphor	*M furfur*	MIC - 0.41 μl/cm³	Vapour Phase method	[30]
			M. sympodialis	MIC - 0.34 μl/cm³		
			M.slooffiae	MIC - 0.44 μl/cm³		
			M.globosa	MIC - 0.1 μl/cm³′		

4 Conclusions

In recent years interest in *Malassezia* species has tremendously increased since this genus has been documented as crucial component for human microorganism with lipid metabolism. These genera comprise of various *Malassezia* species they also may cause similar beneficiary effects, and this is considered by similar vulnerability to the conventional antifungal agents This study will provide much more intelligences on current trends on the activity of EOs those which inhibits various *Malassezia* species, by dissimilar assay methods like broth microdilution, vapor phase method, and agar disk diffusion tests. Nowadays essential oils have been mainly examined against microbials as for more efficacy, less side effects, low cost, and decreased resistance. From this above study results it is proven that the essential oils have promising role to against to fight *Malassezia*-related dermal infections. Though, essential oils might signify thought-provoking constituents′ for medical applications. Nevertheless, additional authoritative research studies with enormous number of patients must carried out in order to authorize the efficiency of essential oils′ against Malassezia species.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

P. versicolor: - Pityriasis versicolor
EOs: - Essential oils

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