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Proceeding Paper

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

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Abstract: It is imperative to classify opportunistic skin pathogens and skin commensals for the *Malassezia* genus of lipophilic yeasts. Recently, in the eastern and western United States, nine types of bat skins have isolated as new *Malassezia* species in the subfamily *Myotinae*. Factually, wild-type *Malassezia* insulates are typically susceptible to azoles, except for fluconazole, although developed azole resistance in these strains has been related to either alterations or quadruplications of the *ERG11* gene. Those remarks have provoked interest in substitute antifungal therapy, such as 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 effect with different plant 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. Yeasts of the class Malassezia have been associated with various ailments influencing the human skin, for example, psoriasis, atopic dermatitis, dandruff, seborrheic dermatitis, folliculitis, *Malassezia* (*Pityrosporum*) and pityriasis Versicolor, and—less commonly—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 exploring cell and humoral immune responses explicit to *Malassezia* species in patients with *Malassezia*-related infections and healthy controls have commonly not been able to characterize critical contrasts in their resistant reactions. Presently, few medications are accessible to treat this fungal infection. The current examination is expected to enhance the clinical utilization of essential oils; there is an urgent need to conduct further in vivo investigations with large cohorts of patients to confirm the clinical capability of essential oils against *Malassezia* species.

Keywords: *Malassezia strains*; phytochemicals; essential oils; antifungal activity; dermatitis; atopic dermatits; *Pityriasis versicolor*; dandruff

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1. Introduction

The *Malassezia* class incorporates a cluster of lipophilic and typically lipid-subordinate yeasts, perceived as individuals from the ordinary skin microbiome of both humans and other homoeothermic life forms [1]. Malassezia is a hazardous species, and in certain conditions, it may also cause folliculitis; *Pityriasis versicolor* can exacerbate numerous dermal infections such as 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, such as ketoconazole, itraconazole, and posaconazole, are most often used against Malassezia-related fungal infections [7,8]. The therapy of this fungal infection differs depending on the severity of infection and lesions. Regularly, it includes systemic/topical imidazole derivatives. From these topical therapies, fungicidal shampoos applied once daily for up to 4 weeks are commonly suggested for the treatment of *P. versicolor*. Widespread *P. versicolor* infection can be treated with various oral antifungals such as fluconazole and itraconazole, which are administered at different doses for up to 7–28 days [9,10]. However, the development of fungal strains resistant to existing antifungals in the market have exposed that progress in novel antifungals is essential in the approach to avoiding overwhelming problems experienced in treating this infection [11].

In the present review, the possible use of essential oils against *Malassezia*-related fungal infections has been studied to provide an indication on their possible effectiveness. Essential oils have been used for thousands of years in different fields, including health and medical purposes, in ancient cultures in India, Greece, China, Egypt, and the Middle East [12,13]. Numerous essential oils have outstanding and varied applications such as demonstrating antimicrobial activity, the preservation of raw and processed food, and health and medical applications. Studies have revealed that essential oils effectively exterminate numerous viral, fungi and bacterial pathogens, including *Candida albicans* and methicillin-resistant *Staphylococcus aureus*. The extensive variety of biochemical compounds present in essential oils leads to antimicrobial activity, attributed to combinations of various biological actions on dissimilar parts of the microbial cell wall; possibly, this is why microorganisms have not developed resistance [14,15]. Therefore, essential oils might be an appropriate choice for replacing conventional antimicrobials, reducing the potential risk and toxicity, and may enhance the therapeutic activity [16,17].

2. Materials and Methods

Data on the inhibitory potential of essential oils from various plants against *Malassezia* species were collected from online databases such as Science Direct, Scopus, PubMed, Taylor, Web of Science, and Google Scholar, and published materials, including E-books. The period covered from January 2008 to 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 have reported the activity of various essential oils against Malassezia spp., evaluating dissimilar assays and 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 studied; their origin was either laboratory collection or clinical isolation from humans and animals. All the authors presented the antifungal activity of various essential oils as well as their MIC (µg/mL) values against various *Malassezia* spp. positively linked to dandruff and seborrheic dermal infection. Evaluations were carried out with different *Malassezia* species concerned with dermal infections, specifically, *M. obtusa*, *M. globosa*, *M. sympodialis*, and *M. slooffiae*. The literature collected from the preceding twelve years has revealed an inordinate diversity of essential oils originating from various medicinal plants, including Artemisia, Myrtus, Thapsia, Syzigium, Rosmarinus, Ocimum, Cinnamomun, Malaleuca, Thymus, Zataria, Origanum, Foenicolum, Tachyspermum. In order to compare 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. Table 2 presents inhibition zones (mm or µL/cm^3) from the activity of some essential oils obtained from steam distillation and verified by different methods: disk diffusion (a), and vapor 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	[18]
2	*Ocimum kilimandscharicum* Gürke	camphor, limonene, camphene	*M. furfur*	128 µg/mL		
3	*Malaleuca leucadendrun* 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		[19]
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 85 µg/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 250 µg/mL 420 µg/mL 410 µg/mL 850 µg/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	[20]
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		[21]
14	*Deverra tortuosa subsp. arabica* Chrtek, Osbornová & Kourková flowers	apiol	*M. furfur*	5.00 µL/mL		[22]
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		[23]

Table 1. *Cont.*

Sl. No.	Source	Main Constituents	*Malassezia species*	MIC	Assay	Reference
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		[24]
18	*Origanum vulgare* L.	thymol, α terpinene, α cymene	*M. furfur*	780 μg/mL		[25]
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), and vapor 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	[26]
2	*Ocimum kilimandscharicum* Gürke	champhor, limonene, camphene	*M. furfur*	8 ± 0.057 mm		
3	*Eucalyptus globulus* Labill.	cineol, p-cymene	*M. furfur*	0 mm		
4	*Malaleuca leucadendrun* 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		[21]
		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* *M. sympodialis*	MIC—0.41 μL/cm^3 MIC—0.34 μL/cm^3	Vapor Phase method	[27]
			M. slooffiae	MIC—0.44 μL/cm^3		
			M. globosa	MIC—0.1 μL/cm^3		

4. Conclusions

In recent years, interest in *Malassezia* species has tremendously increased, since this genus was documented as a crucial component for human microorganisms with lipid metabolism. These genera comprise various *Malassezia* species, and they also may have similar beneficiary effects, and considered to have similar vulnerability to the conventional antifungal agents. This study provides much more detail on current trends on the activity of EOs which inhibit various *Malassezia* species, through dissimilar assay methods such as broth microdilution, the vapor phase method, and agar disk diffusion tests. Essential oils have mainly been examined against microbials due to their greater efficacy, fewer side effects, low cost, and decreased resistance. From these results, it is proven that essential oils have a promising role in the fight against *Malassezia*-related dermal infections.

However, essential oils might represent interesting constituents for medical applications. Nevertheless, additional authoritative research studies with large cohorts of patients must be performed in order to verify the efficiency of essential oils against Malassezia species.

Supplementary Materials: The poster presentation and video are available online at https://www.mdpi.com/article/10.3390/IECPS2020-08838/s1.

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Abbreviations

The following abbreviations are used in this manuscript:

P. versicolor	*Pityriasis versicolor*
EOs	Essential oils

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