

Research Article

ANTIFUNGAL AND ANTIBIOFILM ACTIVITIES OF ESSENTIAL OILS FROM LAMIACEAE
PLANTS AGAINST *MALASSEZIA FURFUR*

ฤทธิ์ต้านเชื้อราและต้านการสร้างไบโอฟิล์มของน้ำมันหอมระเหยจากพืชวงศ์กะเพราต่อเชื้อเกลื้อน

Received: December 11, 2025

Revised: December 25, 2025

Accepted: February 25, 2026

Sasichai Sangchai¹ and Weerapong Juntachai^{1*}

ศศิฉาย แสงฉาย¹ และวีรพงษ์ จันทะชัย^{1*}

¹Department of Biology, Faculty of Science and Technology, Chiang Mai Rajabhat University, Chaing Mai, Thailand

¹ภาควิชาชีววิทยา คณะวิทยาศาสตร์และเทคโนโลยี มหาวิทยาลัยราชภัฏเชียงใหม่ จังหวัดเชียงใหม่ ประเทศไทย

*Corresponding Author, E-mail: weerapong_jun@cmru.ac.th

Abstract

Malassezia furfur is a cutaneous lipophilic yeast commonly found in warm-blood animals and humans. The fungus can become pathogenic under favorable conditions and is associated with both skin disorders and bloodstream infections. The emergence of antifungal resistance underlines the need for alternative antifungals. This study aimed to evaluate the antifungal and antibiofilm activities of essential oils from three Lamiaceae plants, *Ocimum tenuiflorum*, *Vitex negundo*, and *Vitex trifolia*, against five *M. furfur* strains. The paper disc diffusion results showed that *O. tenuiflorum* essential oil (OtEO) showed the most significant inhibition zones (2.33 ± 0.33 mm). The minimum inhibitory concentration (MIC) and minimum fungicidal concentration values of the OtEO were 0.0156% to 0.0625% and 0.0156% to 0.125%, respectively. At sub-MIC, all three EOs demonstrated a high inhibitory effect on fungal biofilm formation. Among these, OtEO showed the highest antibiofilm activity. Our findings suggest that among Lamiaceae essential oils *O. tenuiflorum* has potential as a natural antifungal against *Malassezia*.

Keywords: Essential oil, Lamiaceae, Antifungal, Biofilm, *Malassezia furfur*

บทคัดย่อ

Malassezia furfur หรือเชื้อเกลื้อนเป็นยีสต์ชอบไขมันที่พบได้ทั่วไปบนผิวหนังของสัตว์เลือดอุ่นและมนุษย์ เชื้อเกลื้อนสามารถก่อโรคได้ภายใต้สภาวะที่เอื้ออำนวย และเกี่ยวข้องกับโรคผิวหนังและการติดเชื้อในกระแสเลือด การอุบัติของเชื้อเกลื้อนคือยาต้านเชื้อราทำให้เกิดความจำเป็นในการค้นหาต้านเชื้อราใหม่ การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาฤทธิ์ต้านเชื้อราและฤทธิ์ต้านไบโอฟิล์มของน้ำมันหอมระเหยจากพืชวงศ์กะเพราสามชนิด ได้แก่ กะเพรา (*Ocimum tenuiflorum*), คนทีเขมา (*Vitex negundo*), และ คนทีสอ (*Vitex trifolia*) ต่อเชื้อ *M. furfur* หัวสายพันธุ์ จากผลการทดสอบด้วยวิธี paper disc diffusion แสดงให้เห็นว่า น้ำมันหอมระเหยจากกะเพรา (OtEO) มีฤทธิ์ยับยั้งได้ดีที่สุด โดยมีขนาดวงใสยับยั้ง 2.33 ± 0.33 มิลลิเมตร และการทดสอบด้วย microbroth dilution ให้ค่าความเข้มข้นต่ำสุดที่สามารถยับยั้งเชื้อ (MIC) และค่าความเข้มข้นต่ำสุดที่สามารถฆ่าเชื้อรา (MFC) อยู่ในช่วง 0.0156 ถึง 0.0625%(v/v) และ 0.0156 ถึง 0.125%(v/v) ตามลำดับ ที่ความเข้มข้นต่ำกว่า MIC น้ำมันหอมระเหยทั้งสามชนิดแสดงฤทธิ์ยับยั้งการสร้าง ไบโอฟิล์มของเชื้อราได้เป็นอย่างดี และในบรรดาน้ำมันหอมระเหยเหล่านี้ OtEO แสดงฤทธิ์ต้านไบโอฟิล์มได้สูงสุด ผลการวิจัยของเราชี้ให้เห็นว่า ในกลุ่มน้ำมันหอมระเหยจากพืชวงศ์กะเพรา มีศักยภาพเป็นยาต้านเชื้อราธรรมชาติสำหรับ *Malassezia*

คำสำคัญ: น้ำมันหอมระเหย พืชวงศ์กะเพรา ฤทธิ์ต้านเชื้อรา ไบโอฟิล์ม เชื้อเกลื้อน

บทนำ (Introduction)

A lipophilic yeast *Malassezia furfur* is a member of cutaneous normal flora found on the skins of warm-blooded animals and humans. It can become an opportunistic pathogen under specific conditions that develop in several skin disorders, pityriasis versicolor, seborrheic dermatitis, and folliculitis. The yeast can also cause bloodstream infections in immunocompromised individuals or those receiving parenteral nutrition via catheters (Gaitanis et al., 2012; Saunte et al., 2020). Its ability to form biofilms is one of the fungal virulence factors. The fungal biofilm forms complex microbial communities that allow survival and protective abilities against host immune responses and increase its tolerance to antifungal agents (Sardi et al., 2014). The clinical concern of *Malassezia* spp. has grown recently due to its decreasing susceptibility to conventional antifungal agents thereby complicating treatment strategies for *Malassezia*-associated diseases (Peano et al., 2020; Leong et al., 2021).

Essential oils (EOs) from medicinal plants have potential as alternative antimicrobials due to their antimicrobial properties and natural origin. The plants in the Lamiaceae family, commonly known as the mint family (e.g., mint (*Mentha* spp.), Thai basil (*O. tenuiflorum*), hairy basil (*O. citriodorum*), lavender (*Lavandula* spp.), rosemary (*Rosmarinus officinalis*), blue salvia (*Salvia farinacea*), and oregano (*Origanum vulgare*)) have long been cultivated and used worldwide (Ramasubramania Raja, 2012). In Southeast Asia, they are used as multipurpose as herbal ingredients and folk medicine (Wannissorn et al., 2005). Notably, the Vitex and Basil plants have long been used in herbal folk medicine, recognized in many remedies, including Ayurveda, Chinese traditional medicine, and Southeast Asian traditional medicine. The plants are known for their unique fragrance due to

being rich in essential oils. These oils are rich in bioactive compounds that display a broad spectrum of pharmacological and biological activities of antimicrobial, anti-inflammatory, antioxidant, and anticancer properties (Karpinski 2020). However, regarding *Malassezia*, very few are investigated. Therefore, this study aimed to evaluate and compare the antifungal efficacy of essential oils extracted from three Lamiaceae plants, *O. tenuiflorum*, *V. negundo*, and *V. trifolia*, against *M. furfur*. The findings from this study will provide fundamental scientific data for the potential pharmacological application of *Malassezia* infection therapy

วัตถุประสงค์ (Objectives)

1. To study the efficacy of essential oils from Lamiaceae plants on the inhibition of *M. furfur* growth.
2. To study the efficacy of essential oils from Lamiaceae plants on the inhibition of *M. furfur* biofilm formation.

สมมติฐานการวิจัย (Hypothesis) (ถ้ามี)

1. The essential oils from Lamiaceae plants exhibit inhibitory and fungicidal activities against *Malassezia furfur*.
2. The essential oils from Lamiaceae plants can reduce the biofilm formation of *Malassezia furfur*.

กรอบแนวคิดการวิจัย (Conceptual Framework)

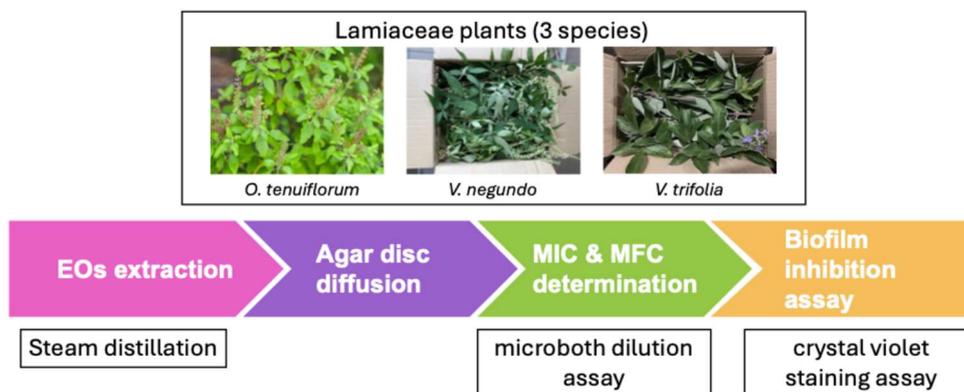


Figure 1 An experimental design of antifungal and antibiofilm activities against *M. furfur*.

วิธีดำเนินการวิจัย (Methodology)

1. Essential oil extraction

Fresh plant samples of *O. tenuiflorum* were collected from Na Noi District, Nan Province, in August 2023. *V. trifolia* and *V. negundo* samples were collected from Wiang Haeng District, Chiang Mai Province, in July 2024. The leaves, stems, and flowers of the plant were washed with distilled water. The plant material was

then subjected to steam distillation using a steam distillation apparatus. The steaming process was maintained for 5 hours at 100 ± 2 °C. The essential oil was collected from the upper oil layer using an oil determination apparatus. All EOs were kept at room temperature in the dark. The herbarium specimens of the collected plants were prepared and verified by a botanist. The herbarium codes for the *O. tenuiflorum*, *V. negundo*, and *V. trifolia* specimens were PHARCOS21, GBQ 150531, and GBQ 150532, respectively. All the specimens are deposited at Queen Sirikit Botanic Garden, Mae Rim District, Chiang Mai Province.

2. Antifungal activity assessment by agar disc diffusion method

For preliminary screening of anti-*Malassezia* activity, *M. furfur* CBS 1878 was used as a representative of *M. furfur*. The strain was subcultured on Yeast Extract Peptone Dextrose Tween (YPDT) agar (1% yeast extract, 2% bacto peptone, 2% dextrose, and 0.5% Tween-80). The yeast was prepared by preculture in YPDT broth at 30 °C, 140 rpm for 48 hours. After incubation, the optical density (OD) of the yeast culture was measured at 600 nm using a spectrophotometer. The concentration of the cell was adjusted to an OD of 1 (approximately 2.5×10^7 cells/ml). The prepared yeast suspension was inoculated onto the surface of YPD-Tween agar plates using a cotton swab.

For the paper disc diffusion assay, each disc contained 5 µl of the essential oil which the concentration was prepared at 5%(v/v) by dilution with dimethyl sulfoxide (DMSO). After placing paper discs onto the YPDT agar, the plates were then incubated at 30 °C for 48 hours. The clear inhibition zone of each plate was measured. Ketoconazole (0.5 µg/disc) and DMSO were used as positive control and negative control, respectively. All experiments were performed in triplicate.

3. Determination of minimal inhibitory concentration (MIC) and minimal fungicidal concentration (MFC)

The *Malassezia* strains used for this study were *M. furfur* CBS 1878, *M. furfur* CBS 6001, *M. furfur* CBS 6046, *M. furfur* CBS 7019^{NT}, and *M. furfur* CBS 9584. For the determination of MIC and MFC values, *M. furfur* cells were precultured and prepared as described above. The fungal cell concentration was adjusted to OD 0.1 with distilled water. The MIC was determined using a broth microdilution assay. Briefly, each well contained 170 µl YPDT broth, 20 µl of prepared cell suspension, and 10 µl of essential oil with a final concentration of 2-0.0039% (v/v). The microplates were incubated at 30 °C, 140 rpm for 72 hours. After the incubation 10 µl of 0.05% Resazurin (RSZ) solution was added to each well. The microplates were kept in the dark at room temperature for 12 hours. The MIC value was determined as the lowest concentration that RSZ did not change color. Consequently, 100 µL aliquots of the culture with no color change were spread onto YPDT agar plates. The plates were incubated at 30 °C for 48 hours. After incubation, fungal colonies on the YPD-Tween agar surface were observed and counted. The MFC was defined as the lowest concentration that resulted in a 99.9%. All experiments were performed in triplicate.

4. Evaluation of essential oil efficacy on *Malassezia furfur* biofilm inhibition

The biofilm inhibition assay was performed in a 96-well microplate. The *M. furfur* CBS 1878 inoculum (OD 1) was prepared as described above. Each well contained 15 µL of the inoculum and 135 µL of YPDT broth. The microplate was incubated at 30 °C, 120 rpm for 24 hours to allow initial biofilm formation. The supernatant

with non-adhesive cells was removed, and then 190 μL of YPDT broth and 10 μL of essential oil were added into each well. YPDT broth with and without fungal cells were used as positive and negative controls. The microplate was incubated at 30 $^{\circ}\text{C}$, 120 rpm for 72 hours. The medium was then discarded, and the wells were washed twice with distilled water. After that, the microplate was dried in a hot air oven at 45 $^{\circ}\text{C}$ for 15 minutes. The biofilms in each well were stained with 200 μL of 0.5% crystal violet solution at room temperature for 45 minutes. Afterward, the wells were washed twice with 250 μL of distilled water to remove excess stains. The stained crystal violet was destained with 250 μL of 99.5% ethanol at room temperature for 45 minutes. Finally, 200 μL of destain from each well was subsequently transferred to a new microplate. The biofilm mass was determined by the absorbance measured at a wavelength of 580 nm using a spectrophotometer. The experiment performed in triplicate. The percent biofilm inhibition was calculated using the following formula:

$$\% \text{ biofilm inhibition} = [(A_{\text{control}} - A_{\text{sample}}) / A_{\text{control}}] \times 100$$

5. Statistical analysis

The experimental data were statistically analyzed using One-way Analysis of Variance (ANOVA) to determine significant differences between three treatment groups based on different essential oil concentrations (0.25 MIC, 0.5 MIC, 1 MIC, and 2 MICs). A p -value less than 0.05 ($p < 0.05$) was considered statistically significant.

ผลการวิจัย (Results)

1. Agar disc diffusion assay.

The initial evaluation of the antifungal efficacy of Lamiaceae EOs was carried out using an agar disc diffusion assay. After incubation, only *O. tenuiflorum* essential oil (OtEO) demonstrated a clear zone of inhibition against *M. furfur*. In contrast, essential oils from *V. negundo* and *V. trifolia* did not exhibit any observable inhibition zones under the experimental conditions (Table 1).

Table 1

Mean \pm standard deviation (SD) diameter of inhibitory zone of three Lamiaceae essential oils by Agar disc diffusion method against *M. furfur* CBS 1878. (ND = No detected zone of inhibitory)

sample	inhibitory zone (mm) \pm SD
<i>Ocimum tenuiflorum</i>	2.33 \pm 0.33
<i>Vitex negundo</i> L.	ND
<i>Vitex trifolia</i> L.	ND
Ketoconazole	18.56 \pm 0.38

2. Minimum Inhibitory Concentration (MIC) and Minimum Fungicidal Concentration (MFC) of Lamiaceae essential oils against *Malassezia furfur*.

The antifungal efficacy of Lamiaceae EOs was further evaluated using a broth microdilution assay against five *M. furfur* strains. In contrast to the results of the disc diffusion assay, all three essential oils possessed inhibitory and fungicidal activities against *M. furfur* strains. OtEO showed the lowest MIC and MFC values across *M. furfur* strains ranging from 0.015625% to 0.0625% and from 0.0156% to 0.125%, respectively. For VnEO, the MIC and MFC values were 0.0625% to 0.25% and 0.125 to 0.5%, respectively. The VtEO showed the highest MIC and MFC values ranging from 0.5% to 2% and from 1 to 2%, respectively. Notably, the susceptibility of *M. furfur* appeared to differ among strains that *M. furfur* CBS 9584 showed the most susceptibility to Lamiaceae EOs (Table 2 and Figure 2).

Table 2

Minimum inhibitory concentration (MIC) and minimum fungicidal concentration (MFC) of three Lamiaceae essential oils against five M. furfur strains.

strains	<i>O. tenuiflorum</i>		<i>V. negundo</i>		<i>V. trifolia</i>		Ketoconazole	
	MIC (%) ± SD	MFC (%) ± SD	MIC (%) ± SD	MFC (%) ± SD	MIC (%) ± SD	MFC (%) ± SD	MIC (µg/ml) ± SD	MFC (µg/ml) ± SD
<i>M. furfur</i> CBS 1878	0.0313 ± 0	0.0625 ± 0	0.25 ± 0	0.33 ± 0.14	2 ± 0	2 ± 0	1 ± 0	2 ± 0
<i>M. furfur</i> CBS 6001	0.0313 ± 0	0.0313 ± 0	0.25 ± 0	0.25 ± 0	2 ± 0	2 ± 0	1 ± 0	2 ± 0
<i>M. furfur</i> CBS 6046	0.0156 ± 0	0.0313 ± 0	0.125 ± 0	0.25 ± 0	0.5 ± 0	1 ± 0	2 ± 0	2 ± 0
<i>M. furfur</i> CBS 7019 ^{NT}	0.0625 ± 0	0.125 ± 0	0.25 ± 0	0.5 ± 0	1 ± 0	2 ± 0	1 ± 0	1.67 ± 0.58
<i>M. furfur</i> CBS 9584	0.0156 ± 0	0.0156 ± 0	0.0625 ± 0	0.125 ± 0	0.5 ± 0	1 ± 0	1 ± 0	1 ± 0

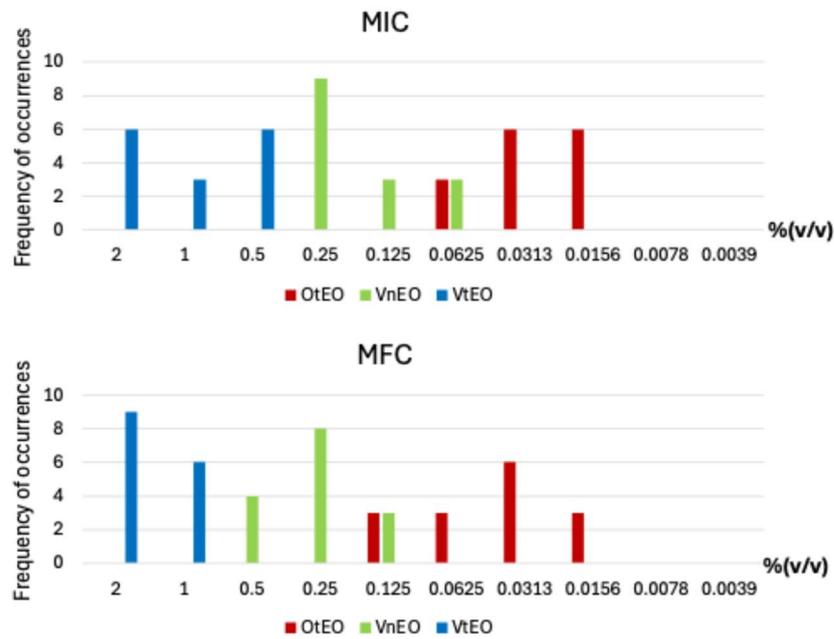


Figure 2 The susceptibility of three Lamiaceae essential oils against five *M. furfur* strains expressed as the frequency of occurrences in experimental replicates.

3. Evaluation of Antibiofilm Efficacy of Lamiaceae Essential Oil on *Malassezia furfur*.

The biofilm inhibitory efficacy of three essential oils from OtEO, VnEO, and VtEO on *M. furfur* CBS 1878 was evaluated at various concentrations based on the MIC value (0.25 MIC, 0.5 MIC, 1 MIC, and 2 MIC). The three essential oils demonstrated a high inhibitory effect on *M. furfur* biofilm formation in any tested concentrations. No statistical difference in biofilm inhibition was observed among samples when the concentration was above 0.5MIC. Interestingly, at a concentration of 0.25MIC, the biofilm inhibition of VtEO significantly decreased to 53% while other EOs remained above 80% (Figure 3).

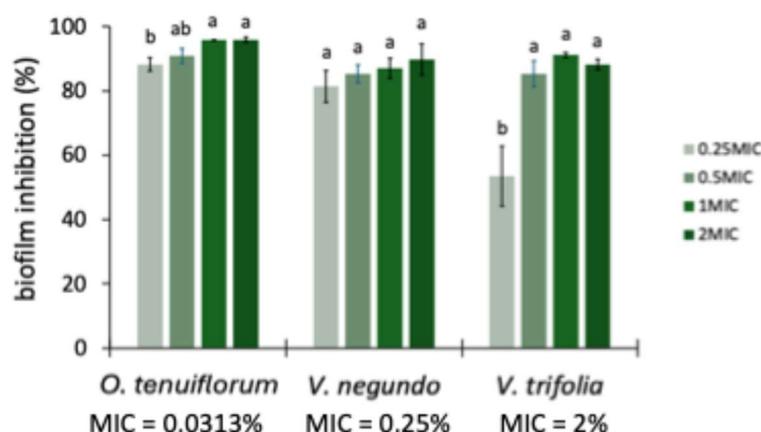


Figure 3 Efficacy of biofilm inhibition of three Lamiaceae essential oils against *M. furfur* CBS 1878. Different letters above the bars indicate statistically significant difference ($p < 0.05$) among concentrations within the same species.

อภิปรายผล (Discussions)

The increasing prevalence of azole-resistant *Malassezia* strains underscores the necessity to discover novel antifungal agents. The plants belonging to Lamiaceae have long been used as folk remedies in many cultures and have potential as alternative antimicrobials. Therefore, in this study, we evaluated the antifungal and antibiofilm efficacy of essential oils extracted from three Lamiaceae herbs against *M. furfur*. The essential oils (EOs) extracted from all studied plants exhibited similar physical characteristics, characterized by a pale-yellow color and a distinctive aromatic odor. All EOs were insoluble in water but highly volatile (data not shown). The preliminary examination by agar disc diffusion showed that only OtEO exhibited a clear zone of inhibition against. In contrast, VnEO and VtEO did not show observable inhibition zones under the experimental conditions. The discrepancy in both assays may be due to the intrinsic volatility and solubility of certain essential oil components present in different EOs. The evaluation of EO via paper disc diffusion assay is difficult because if the important bioactive substances rapidly evaporate, their observable effect in the agar matrix will decrease. The results of the broth microdilution assay confirmed the antimicrobial efficacy of all three Lamiaceae EOs. The observed antifungal activity of OtEO aligns with previous studies reporting its potent inhibitory effects against *Candida* spp. and *Cryptococcus neoformans* (Amber et al., 2010; Khan et al., 2010; Powers et al., 2018).

While the growth inhibition effect against several fungal species, OtEO possesses a broad range of MIC values from extremely low concentrations of 3 $\mu\text{g/ml}$ (*C. guilliermondii*) to very high concentrations of 10000 $\mu\text{g/ml}$ (*Aspergillus* spp.). Notably, pathogenic yeast species appear to be more susceptible to OtEO compared to mold fungi (Karpinski, 2020). Intriguingly, our results indicate that *M. furfur* shows less resistance to OtEO than that of a basidiomycetous yeast, *C. neoformans*, suggesting the potential use of OtEO as an anti-*Malassezia* agent. In

contrast to the studies regarding *O. tenuiflorum*'s EO, the antifungal properties of EOs derived from *Vitex* species are little understood. It has been reported that Eos from *V. agnus-castus* and *V. pseudo-negundo* had strong antifungal effects against *Candida* spp (Asdadi et al., 2015; Zareshahrabadi et al., 2023). These EOs consist of pinene as the main chemical. However, in this study, VnEO and VtEO did not indicate such dominant growth inhibition on *M. furfur*. Therefore, chemical component analysis is required for the investigation of possibly different compounds that exist in these EOS.

The ability of *Malassezia* species to form biofilms is a critical virulence factor that significantly reduces susceptibility to conventional antifungals (Cannizzo et al., 2007; Figueredo et al., 2013). While some therapeutic strategies have explored monoclonal antibodies or chitosan to prevent initial adhesion (Martinez et al., 2006; Martinez et al., 2010), our findings suggest that essential oils show a potent alternative for targeting the early stages of biofilm development, similar to the previous studies (Palmeira-de-Oliveira et al., 2012; Zareshahrabadi et al., 2023). Among the Lamiaceae EOs tested, OtEO exhibited superior antibiofilm activity even at sub-inhibitory concentrations, effectively suppressing more than 90% of *M. furfur* biofilm. This high efficacy at low concentrations highlights OtEO as the most promising candidate for further development. Future investigation should be focused on identifying the specific bioactive compounds responsible for antifungal and antibiofilm properties, along with toxicity evaluations.

สรุปผล (Conclusion)

This study proves the antifungal and antibiofilm efficacy of the essential oils extracted from Lamiacea plants of *O. tenuiflorum*, *V. negundo*, and *V. trifolia* against *M. furfur* strains. Among the three EOs, OtEO exhibited the most significant anti-*Malassezia* and anti-biofilm efficacy toward *M. furfur*, while the other two EOs showed little effect. Our findings provide scientific evidence for the antifungal and antibiofilm properties of *O. tenuiflorum* as a prominent candidate for the development of novel antifungals and antibiofilm against *Malassezia*. Further investigation is required to elucidate the mode of action and identify bioactive compounds in these EOs.

ข้อเสนอแนะ (Recommendations)

1. ข้อเสนอแนะในการนำผลการวิจัยไปใช้

1.1 The strong antifungal and antibiofilm effects of essential oil from *O. tenuiflorum* suggest its potential use as a natural active ingredient in medical or cosmetic products for managing *Malassezia*-related skin conditions.

1.2 The ability of essential oils to inhibit biofilm formation at sub-MIC levels provides a basis for developing new antifungal formulations targeting fungal adhesion.

2. ข้อเสนอแนะในการทำวิจัยครั้งต่อไป

2.1 Chemical composition analysis of the essential oils should be conducted to identify the specific bioactive compounds responsible for antifungal and antibiofilm activities.

2.2 Toxicity and safety evaluations in human skin cells or in vivo models should be performed to assess the suitability of these essential oils for medical or cosmetic applications.

กิตติกรรมประกาศ (Acknowledgements) (ถ้ามี)

This work was supported by the Research and Development Institute, Chiang Mai Rajabhat University, for providing the research fund [no. 24-67].

เอกสารอ้างอิง (References)

- Amber, K., Aijaz, A., Immaculata, X., Luqman, K. A., & Nikhat, M. (2010). Anticandidal effect of *Ocimum sanctum* essential oil and its synergy with fluconazole and ketoconazole. *Phytomedicine: international journal of phytotherapy and phytopharmacology*, 17(12), 921–925.
- Asdadi, A., Hamdouch, A., Oukacha, A., Moutaj, R., Gharby, S., Harhar, H., El Hadek, M., Chebli, B., & Idrissi Hassani, L. M. (2015). Study on chemical analysis, antioxidant and in vitro antifungal activities of essential oil from wild *Vitex agnus-castus* L. seeds growing in area of Argan Tree of Morocco against clinical strains of *Candida* responsible for nosocomial infections. *Journal de mycologie medicale*, 25(4), e118–e127.
- Cannizzo, F. T., Eraso, E., Ezkurra, P. A., Villar-Vidal, M., Bollo, E., Castellá, G., Cabañes, F. J., Vidotto, V., & Quindós, G. (2007). Biofilm development by clinical isolates of *Malassezia pachydermatis*. *Medical mycology*, 45(4), 357–361.
- Figueredo, L. A., Cafarchia, C., & Otranto, D. (2013). Antifungal susceptibility of *Malassezia pachydermatis* biofilm. *Medical mycology*, 51(8), 863–867.
- Gaitanis, G., Magiatis, P., Hantschke, M., Bassukas, I. D., & Velegaki, A. (2012). The *Malassezia* genus in skin and systemic diseases. *Clinical microbiology reviews*, 25(1), 106–141.
- Karpinski T. M. (2020). Essential Oils of Lamiaceae Family Plants as Antifungals. *Biomolecules*, 10(1), 103.
- Khan, A., Ahmad, A., Akhtar, F., Yousuf, S., Xess, I., Khan, L. A., & Manzoor, N. (2010). *Ocimum sanctum* essential oil and its active principles exert their antifungal activity by disrupting ergosterol biosynthesis and membrane integrity. *Research in microbiology*, 161(10), 816–823.
- Leong, C., Kit, J. C. W., Lee, S. M., Lam, Y. I., Goh, J. P. Z., Ianiri, G., & Dawson, T. L., Jr (2021). Azole resistance mechanisms in pathogenic *M. furfur*. *Antimicrobial agents and chemotherapy*, 65(5), e01975-20.
- Martinez, L. R., Christaki, E., & Casadevall, A. (2006). Specific antibody to *Cryptococcus neoformans* glucuronoxylomannan antagonizes antifungal drug action against cryptococcal biofilms in vitro. *The Journal of infectious diseases*, 194(2), 261–266.
- Martinez, L. R., Mihu, M. R., Tar, M., Cordero, R. J., Han, G., Friedman, A. J., Friedman, J. M., & Nosanchuk, J. D. (2010). Demonstration of antibiofilm and antifungal efficacy of chitosan against candidal biofilms,

- using an in vivo central venous catheter model. *The Journal of infectious diseases*, 201(9), 1436–1440.
- Palmeira-de-Oliveira, A., Gaspar, C., Palmeira-de-Oliveira, R., Silva-Dias, A., Salgueiro, L., Cavaleiro, C., Pina-Vaz, C., Martinez-de-Oliveira, J., Queiroz, J. A., & Rodrigues, A. G. (2012). The anti-Candida activity of *Thymbra capitata* essential oil: effect upon pre-formed biofilm. *Journal of ethnopharmacology*, 140(2), 379–383.
- Peano, A., Johnson, E., Chiavassa, E., Tizzani, P., Guillot, J., & Pasquetti, M. (2020). Antifungal Resistance Regarding *Malassezia pachydermatis*: Where Are We Now?. *Journal of fungi (Basel, Switzerland)*, 6(2), 93.
- Powers, C. N., Osier, J. L., McFeeters, R. L., Brazell, C. B., Olsen, E. L., Moriarity, D. M., Satyal, P., & Setzer, W. N. (2018). Antifungal and Cytotoxic Activities of Sixty Commercially-Available Essential Oils. *Molecules (Basel, Switzerland)*, 23(7), 1549.
- Ramasubramania Raja, R. (2012). Medicinally Potential Plants of Labiatae (Lamiaceae) Family: An Overview. *Research Journal of Medicinal Plants*, 6, 203-213
- Sardi, J.deC., Pitangui, N.deS., Rodríguez-Arellanes, G., Taylor, M. L., Fusco-Almeida, A. M., & Mendes-Giannini, M. J. (2014). Highlights in pathogenic fungal biofilms. *Revista iberoamericana de micologia*, 31(1), 22–29.
- Saunte, D. M. L., Gaitanis, G., & Hay, R. J. (2020). *Malassezia*-Associated Skin Diseases, the Use of Diagnostics and Treatment. *Frontiers in cellular and infection microbiology*, 10, 112.
- Wannissorn, B., Jarikasem, S., Siriwangchai, T., & Thubthimthed, S. (2005). Antibacterial properties of essential oils from Thai medicinal plants. *Fitoterapia*, 76(2), 233–236.
- Zareshahrabadi, Z., Saharkhiz, M. J., Izadpanah, M., Iraj, A., Emamina, M., Motealeh, M., Khodadadi, H., & Zomorodian, K. (2023). Chemical Composition and Antifungal and Antibiofilm Effects of *Vitex pseudo-negundo* Essential Oil against Pathogenic Fungal Strains. *Evidence-based complementary and alternative medicine : eCAM*, 2023, 3423440.