CHEMICAL COMPOSITION AND BIOLOGICAL ACTIVITIES OF ESSENTIAL OIL EXTRACTED FROM TURMERIC RHIZOMES (*Cucurma longa* L.)

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ABSTRACT

In this work, turmeric essential oil was extracted from fresh turmeric rhizomes grown in Tien Giang province via hydrodistillation. The efficiency of turmeric essential oil extraction was examined in terms of material/solvent ratio (w/v), extraction time (minutes), and Tween 20 surfactant concentration. Turmeric essential oil has high levels of α-turmerone (16.49%), 7-epi-Sesquithujene (9.0%), α-Santalene (8.17%), β-sesquiphellandrene (7.02%), Teresantalol (6.29), and ar-turmerone (5.85%), according to gas chromatography-mass spectrometry analysis. The antioxidant activity of turmeric essential oil was evaluated using the DPPH free radical elimination method, yielding an IC_{50} value of 94.80 mg/mL. Furthermore, the disc diffusion method was used to assess the antifungal activity of essential oils against five fungus strains: *Malassezia furfur, Canida albicans, Aspergillus flavus*, *Aspergillus niger*, and *Fusarium oxysporum*. Turmeric essential oil expressed highly effective antifungal activity against *Fusarium oxysporum, Aspergillus flavus*, and *Canida albicans*, with antifungal diameters of 20 mm, 14 mm, and 9 mm, respectively. The above results confirmed that turmeric oil can be potentially used in biopesticides and personal care products.

Keywords: Biopesticides, turmeric essential oil, antifungal activity, turmerone, GC/MS.

1. INTRODUCTION

Turmeric, or *Curcuma longa L.*, is a plant that belongs to the Zingiberaceae (Ginger) family [1, 2]. This plant is predominantly found in subtropical and East Asian nations such as Indonesia, China, Thailand, Cambodia, Laos, and India. After harvesting, all turmeric leaves, roots, and stems are chopped off to obtain the rhizomes. Turmeric rhizomes are processed into a dark orange-yellow powder that is commonly used as a food additive or pigment [3, 4]. Turmeric is also commonly used to treat the flu, arthritis, jaundice, and stomach ulcers. Curcuminoids and essential oils are the two primary components that contribute to the biological activity of turmeric rhizomes [3, 4]. Curcuminoids have many biological properties, including anti-cancer, anti-inflammatory, antioxidant, and anti-Alzheimer effects [4]. Turmeric essential oil has received minimal attention in comparison to curcumin and curcuminoids in general. Turmeric essential oil contains volatile organic molecules, including ar-turmerone, α-turmerone, and β-turmerone, which have biologically active qualities such as antibacterial, antioxidant, anti-inflammatory, and extremely anti-cancer [4, 5]. Typically, the volatile turmeric oil content ranges between 1.5% and 6.0% of the dry weight of turmeric

rhizomes [4]. In addition to its usage as a taste enhancer in food, turmeric essential oil has the potential to be used in the agricultural and food industries due to its bioactivities [4-9]. Many studies indicated that turmeric essential oil can resist fungi such as *Phytophthora* infestans (which causes late blight), *Fusarium oxysporum* (which produces yellow wilt disease), and *C. gloeosporioides*, *C. orbiculare*, and *C. acutatum* (which causes anthracnose) [4-10]. *Colletotrichum gloeosporioides, Sphaceloma cardamomi*, and *Pestalotia palmarum* were fully killed when treated with the essential oil of *C. longa* rhizomes at 1-6% [4].

Although there have been numerous studies on the biological activity of turmeric essential oil around the world, there have been few investigations on the antifungal activity of Vietnamese turmeric essential oil against a wide range of fungi. In Vietnam, a study on dried shrimp protective film containing turmeric essential oil was conducted in 2016 [11]. Their results demonstrated that turmeric essential oil may fight *Staphylococcus aureus, Escherichia coli, Penicillium sp*., and *Aspergillus flavus*. Dried shrimp treated with a preservative solution comprising 15.6 mL/L turmeric essential oil and 0.5% chitosan can reduce total aerobic bacteria, yeast, and mold during storage. In 2021, Pham et al. published the antifungal efficacy of turmeric essential oil derived by solvent extraction with n-hexane of turmeric oleoresin [12]. Turmeric essential oil at 1 mg/mL had the strongest inhibitory impact (67.9%) against the fungus strain *C. gloeosporioides* isolated from lychees, which causes anthracnose on lychees.

In this study, the extraction procedure, chemical composition, and bioactivities of essential oil extracted from *Curcuma longa L.* fresh rhizomes in Tien Giang province, Viet Nam were investigated. The raw material/solvent ratio, distillation time, and Tween 20 effect were all investigated as factors influencing essential oil content throughout the distillation process. Gas chromatography–mass spectrometry (GC/MS) was used to determine the composition of volatile compounds. Especially, the antifungal activity of essential oils was tested on five fungal species that cause infections in humans and plants, including Malassezia furfur, Canida albicans, Aspergillus flavus, Aspergillus niger, and Fusarium oxysporum which have not been studied yet. In addition, turmeric essential oil has been shown to have antioxidant properties.

2. MATERIALS AND METHOD

2.1. Materials

Fresh turmeric rhizomes cultivated in Tien Giang in September 2023 were bought, washed, dried, and drained. Tween 20, sodium sulfate, and ethanol were provided by Xilong (Chinese), as well as 2,2-diphenyl-1-picrylhydrazyl (DPPH) from Sigma Aldrich. Double-distilled water was used in all experiments. All of these chemicals were used without further purification.

2.2. Extraction procedures

The turmeric rhizomes are pulverized and placed in a 1-liter flask, along with the appropriate amount of water to match the solvent ratio. The Clevenger apparatus was used for approximately 2 hours of hydrodistillation. Essential oil samples were processed with anhydrous sodium sulfate and stored at approximately 4°C for subsequent analysis. The essential oil (TEO) content is measured by weighing the essential oil and calculated by the percentage of essential oil per the mass of turmeric after removing the moisture. The raw material/solvent ratio (1:2.5, 1:4, 1:5 w/v), extraction time (60, 90, 120, 150, 180 minutes), and Tween 20 surfactant concentration (250, 500, 1000, 1500 mg/L) were all examined. The experiment was repeated three times.

2.3. Determination of physicochemical properties of essential oil

Turmeric oil was evaluated the physicochemical properties such as appearance, specific gravity, reflective index, acid value, and iodine value by TCVN methods.

2.4. Gas chromatography-mass spectrometry (GC/MS) analysis

The composition of turmeric oil was analyzed using the gas chromatographs GC-2030 (Shimadzu, Japan) and GCMS-QP2020 (Shimadzu, Japan). A Shimadzu Rxi-5MS capillary column 30 m long with an internal diameter of 0.25 mm and a film thickness of 0.25 mm was used. The column head temperature was set to 50°C for 2 minutes, then increased to 80°C at a rate of 2°C/min, 150°C at a rate of 5°C/min, 200°C at a rate of 10°C/min, and 300°C at a rate of 20°C/min, with a 5-minute hold. The ion source temperature is 260 °C. The interface temperature is 260 °C. Helium was used as the carrier gas at a flow rate of 1.69 mL/min. Split injection in a 1:10 ratio was used, with a column head pressure of 100 KPa. The composition of volatile compounds in turmeric essential oil was analyzed using the NIST library.

2.5. Determination of antioxidant activity of essential oil

The antioxidant activity of turmeric essential oil was evaluated using 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scaveging method. The purple DPPH solution transforms to the yellow color of DPPH-H when ^{1} H atom is introduced implying free radical scavenging. The series of different concentrations of turmeric essential oil from 10 mg/mL to 100 mg/mL was diluted in ethanol. The mixtures consisting of two milliliters of diluted essential oil and two milliliters of DPPH solution 0.5 mM were shaken strongly and let it remain stable for 30 minutes at room temperature, away from light. After that, absorbance at wavelength λ = 517 nm was measured for the mixture. The following formula (Eq.1) was used to compute the percentage of DPPH radical removal:

$$\text{DPPH (\%)} = \frac{A_b - A_s}{A_b} \quad \text{(Eq. 1)}$$

Whereas: A_b: Absorbance of blank

A_s: Absorbance of sample

Based on the diluted concentration of essential oil and the standard curve of % anti-DPPH activity, the concentration of essential oil that can withstand 50% of DPPH free radicals (IC50) is determined. Ascorbic acid (Vitamin C) was employed as a comparison.

2.6. Antifungal assay

The disc diffusion technique is used to test for antifungal activity. Five different species of fungus: *Malassezia furfur* ATCC 14521, *Canida albicans* ATCC 10231, *Aspergillus flavus* ATCC 9643, *Aspergillus niger* ATCC 6275, *Fusarium oxysporum* ATCC 62506 were chosen to evaluate antifungal activity at the Viet Tin Analysis Center. 100 µL fungi (10^9 CFU/mL) were spread on a petri dish filled with Mueller Hinton agar for testing. Sterile filter paper disks with a diameter of 6 mm were used in this test.

3. RESULTS AND DISCUSSION

3.1. Extraction yield of essential oil from Curcuma longa L. rhizomes

The effect of raw material/solvent ratio (R/S), extraction time, and surfactant concentration on the extraction yield is demonstrated in Figure 1. The raw material/solvent ratio increased from 1:2.5 to 1:5 resulting in an increase in essential oil content from 2.73% to 3.6%, with an optimal efficiency of 4.09% at the R/S of 1:4 (Figure 1(a)). When water is

heated, it penetrates the cell membrane and enters the cells carrying essential oils, causing them to enlarge and rupture. The essential oils disseminate and are attracted by the steam in the water. If a low material/solvent ratio is utilized, the amount of water that penetrates the cell is insufficient to dissolve the cell membrane components, lowering the rate of absorption of water vapor into the cell. However, if there is too much water, the polar components in the essential oil will dissolve in it, causing the essential oil to be lost. Hence, the appropriate material/solvent ratio of 1:4 was chosen for the next experiments.

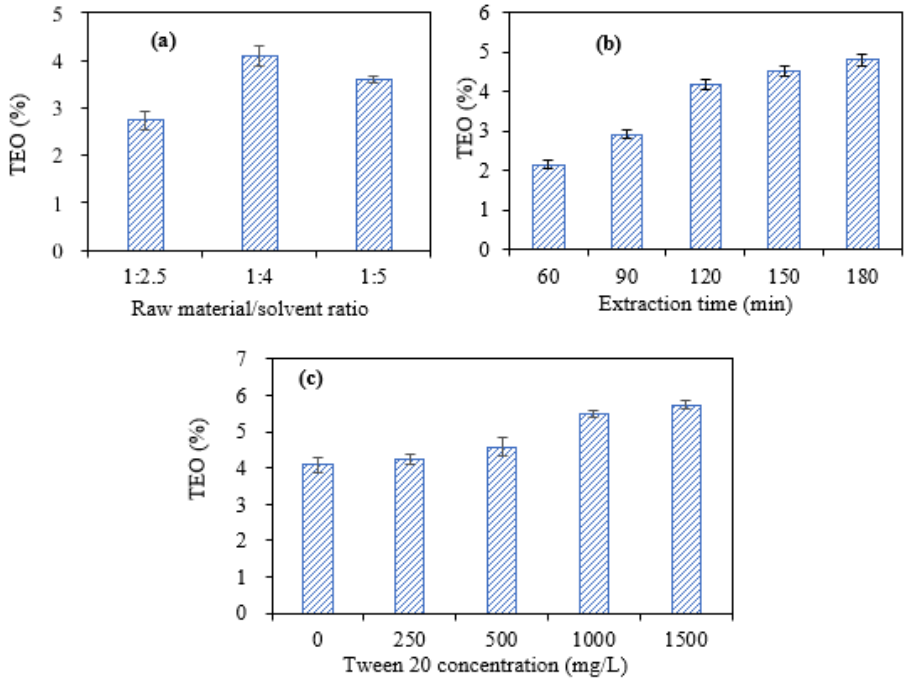

Figure 1. (a) Effect of raw material/solvent ratio, (b) Extraction time, (c) Tween 20 concentration on the TEO yield.

Extraction time is also a significant consideration in the hydrodistillation. Fig 1(b) indicates that the content of turmeric essential oil increases with distillation time, with longer distillation times yielding more essential oil. In detail, when the extraction period was prolonged from 60 to 120 minutes, the essential oil content increased significantly from 2.15% to 4.16%. However, there was a slight increase in the essential oil content from 4.16% to 4.81% when the extraction time increased from 120 mins to 180 mins. Although distillation for an additional 60 minutes enhanced the efficiency of essential oil extraction by 15%, it also increased distillation time and energy costs. As a result, the ideal distillation time of 120 minutes was selected for the hydrodistillation process.

Previous research has demonstrated that surfactants can improve extraction efficiency [13, 14]. Polysorbate (Tween 20) is a non-ionic surfactant that lowers the surface tension between two immiscible phases, enhancing surface wetting. The addition of an appropriate surfactant in the aqueous extractant is thought to aid in the mobilization and quick release of oil molecules from plant tissues into the liquid extraction phases. As a result, the addition of surfactants can improve the extraction yield and kinetics of essential oils during the distillation process. Figure 1(c) illustrates the effect of Tween 20 concentration on the extracted essential oil content. The results pointed out that as the Tween 20 concentration increased from 0 to 1000 mg/L, the essential oil rose significantly from 4.58% to 5.48%. However, the essential oil content increased slightly by only 0.26% between concentrations of 1000 mg/L and 1500 mg/L.

The survey results revealed that the raw material/solvent ratio, extraction time, and tween 20 concentration all had significant effects on the extraction efficiency of turmeric essential oil. The optimum essential oil content was 5.7% after 120 minutes of distillation at a material/solvent ratio of 1:4 in the presence of Tween 20 at 1500 mg/L. The essential oil yield of Tien Giang turmeric rhizomes is consistent with earlier investigations, ranging between 1-6%. Essential oil derived from turmeric by hydrodistillation in India, China, and Nepal had a concentration of 3.05%, 4.5%, and 3%, respectively [15-17]. Meanwhile, microwave-assisted hydrodistillation of Bazil turmeric yielded 0.6% [18]. In Vietnam, the essential oil content of Thai turmeric and Xa Cu turmeric cultivars in Bay Nui, An Giang province were 6.62% and 5%, respectively [6]. This showed that the yield of essential oils is influenced by the source of raw materials and environmental factors. Additionally, the quality of turmeric essential oil is influenced by nutritional conditions. Mineral addition and fertilization of turmeric plants improve the extraction of essential oil as well as the makeup of volatile components [19].

3.2. Physico-chemical properties of turmeric essential oil

The essential oil of turmeric rhizomes was pale yellow and had a distinct odor (see Fig. 2). Table 1 shows TEO's specific gravity and refractive index at 25 °C were 0.9190 ± 0.0002 g/mL and 1.4608 ± 0.0007, respectively, similar to Paul's findings [20]. The chemical properties, such as acid and iodine value, were within the range of turmeric essential oil.

Table 1. The physico-chemical parameters of the essential oil produced from Tien Giang turmeric.

Property	Value
Appearance (25 °C)	Pale yellow colour with typical turmeric odour
Specific gravity (25 °C) (g/mL)	0.9190 ± 0.0002
Refractive index (RI)	1.4608 ± 0.0007
Acid value	1.73 ± 0.12
Iodine value	82.3 ± 2.9

Figure 2. Turmeric essential oil and RI meter

3.3. Chemical composition of turmeric essential oil

The chemical composition of turmeric essential oil analyzed by GC/MS is shown in Figure 3 and Table 2. The compounds were identified using the NIST library. For quantitation, the percentage peak area method was used to compute the percentage of compound in the TEO sample.

Table 2. The composition of turmeric essential oil

No.	RT (min)	Compound	RI (*)	Area %
1	7.127	α-pinene	926	0.21
2	9.733	β-Myrcene	986	0.14
3	10.495	l-Phellandrene	1002	2.80
4	11.463	m-Cymol	1018	0.33
5	11.737	Bornylene	1023	0.27
6	11.845	1,8-cineole	1025	3.01
7	13.421	γ-Terpinene	1052	0.10
8	15.044	α -terpinolene	1079	0.51
9	21.101	α -Terpineol	1190	0.13
10	28.223	β -Elemene	1386	0.10

No.	RT (min)	Compound	RI (*)	Area %
11	29.159	α -Santalene	1417	8.17
12	29.551	α -Bergamotene	1431	1.74
13	29.933	epi- β -Santalene	1445	0.95
14	30.132	β-Famesene	1452	3.30
15	30.282	β -Santalene	1457	0.22
16	30.895	α -Curcumene	1479	1.50
17	31.321	7-epi-Sesquithujene	1494	9.00
18	31.437	α -Bisabolene	1498	0.15
19	31.636	β -Bisabolene	1507	4.40
20	31.893	Teresantalol	1519	6.29
21	32.026	β -Sesquiphellandrene	1525	7.02
22	32.084	(E)-1-Methyl-4-(6-methylhept-5-en-2-ylidene)cyclohex-1-ene	1528	1.07
23	32.176	α -Santalol	1532	1.03
24	32.402	Santolina triene	1543	0.66
25	32.654	trans- α -Bergamotene	1555	0.66
26	32.795	(-)-Caryophyllene oxide	1561	0.53
27	33.158	Perilla alcohol tiglate	1579	4.83
28	33.387	γ -Atlantone	1589	2.68
29	33.432	Bergamotol, Z-.alpha.-trans-	1591	0.39
30	33.539	Germacrone	1596	0.25
31	33.580	propan, 2-cyclohexyl-2-phenyl-	1598	0.11
32	33.633	geranyl- α -terpinene	1601	0.38
33	33.692	Santolina triene	1605	0.52
34	33.748	2-Methyl-6-methyleneocta-2,7-dien-4-one	1608	0.14
35	33.837	α - Cedrol	1613	0.89
36	33.950	2,3-dibromo-8-phenyl-p-menthane	1620	0.28
37	34.142	Zingiberene	1632	0.53
38	34.195	Lanceol	1635	0.39
39	34.248	α-Atlantone	1638	0.15
40	34.452	Campherenone	1650	0.19
41	34.570	hedycaryol	1657	0.24
42	34.704	aR-Turmerone	1665	5.85
43	34.815	Tumerone	1672	16.49
44	34.914	(-)-isolongifolol	1678	3.49
45	35.070	trans-Sesquisabinene hydrate	1687	0.92
46	35.213	(E,E)-Germacrone	1696	1.39
47	35.304	Curlone	1702	4.49
48	35.442	α -Santalol	1712	0.27
49	35.902	(6R,7R)-Bisabolone	1746	0.46
50	36.315	(E)-Atlantone	1776	0.36

(*) RI: Kovats Retention Index.

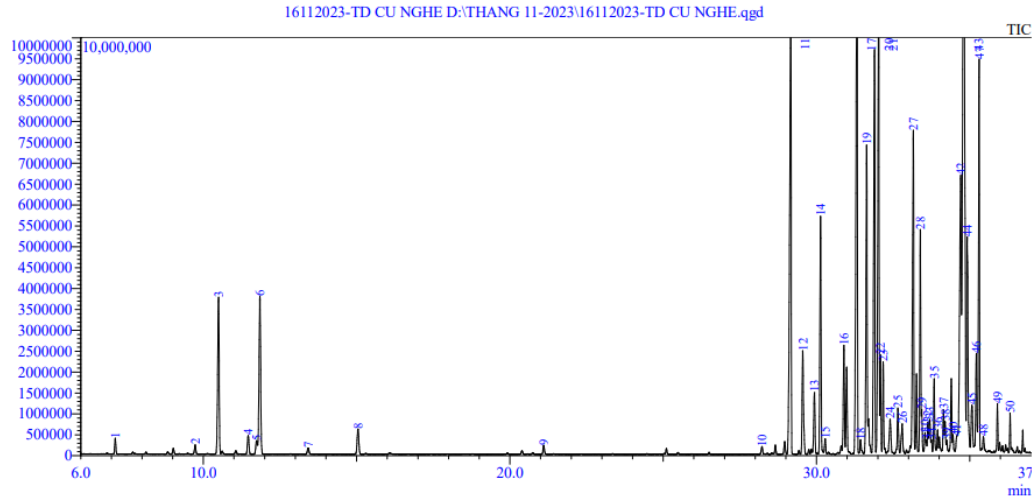

Figure 3. GC/MS chromatogram of turmeric essential oil

GC/MS chromatogram demonstrates that Tien Giang turmeric contained total of 50 volatile chemicals. The primary volatile constituents were determined to be chemicals that fall under the class of sesquiterpene and its derivatives, including α-turmerone (16.49%), α-turmerone (16.49%), 7-epi-Sesquithujene (9.0%), α -Santalene (8.17%) and β-sesquiphellandrene (7.02%), Teresantalol (6.29), và ar-turmerone (5.85%) (Table 2). In addition, five compounds such as Curlone, β-Famesene, β-bisabolene, Perilla alcohol tiglate , and (-)-isolongifolol (3.49%) with concentrations ranging from 3.3 – 5.0% were identified. Monoterpenes and their derivatives were found in tiny amounts, including α-Terpineol, α-pinene, and 1,8-cineole. This conclusion is consistent with earlier research on turmeric essential oil. Turmeric essential oil contains α-turmerone and ar-turmerone, with quantities ranging from 10% to 50%. These two chemicals contribute to anti-cancer, anti-inflammatory, antioxidant, and anti-dementia activities [1]. They also improve the bioavailability and activity of other essential turmeric components such as curcumin. The overall content of α-turmerone and ar-turmerone in this work was 22.35%, comparable to some turmeric samples in Nepal but lower than local research. Nepalese turmeric essential oil samples contained α- and β-turmerones (8.19% and 17.74%, respectively), and zingiberene (4.03%) [17]. Turmeric essential oil samples from South America, including Ecuador, included high levels of ar-turmerone (45.5%) and α-turmerone (13.4%) [21], while Brazil mostly contained ar-turmerone (50.4%), β-turmerone (14.4%), and α-curcumen (6.2%) [18]. Turmeric rhizome obtained in Hung Yen, Vietnam, contained α-turmerone and ar-turmerone accounting for more than 44% of the essential oil content, followed by sesquiterpenes such as β-sesquiphellandrene, α-Zingberene, and β-caryophyllene accounting for more than 10% [9]. Xa Cu turmeric essential oil originated in An Giang, Viet Nam had 48.05% ar-turmerone and 18.17% α-turmerone [6]. Pham et al. found α-turmerone (16.68%) and ar-turmerone (16.55%) in turmeric oil extracted from yellow turmeric root using n-hexane distribution extraction technique [12]. In this study, Tien Giang turmeric contained high levels of 7-epi-Sesquithujene and α-Santalene. This demonstrates that regional and environmental factors will impact the quality and content.

3.4. DPPH antioxidant activity of turmeric essential oil

The analysis results in Figure 4 show that as the essential oil concentration gradually increased from 10 mg/mL to 100 mg/mL, the antioxidant activity increased from 12.3% to 52.6% with the standard curve equation for DPPH resistance of essential oils, which is y= 43.383x + 8.8728 (correlation coefficient $R^2 > 0.9885$). At a concentration of 94.80 mg/mL,

the extracted essential oil can inhibit 50% of DPPH-free radicals. As a result, Tien Giang turmeric essential oil exhibited weaker DPPH antioxidant activity than Avanço and colleagues (2017) with an IC_{50} value of 10.03 mg/mL [22]. This was explained by the difference in the chemical composition of TEO. The antioxidant activity of vitamin C standards was verified and found to be 7.70 µg/mL, which is 50% resistant to DPPH free radicals.

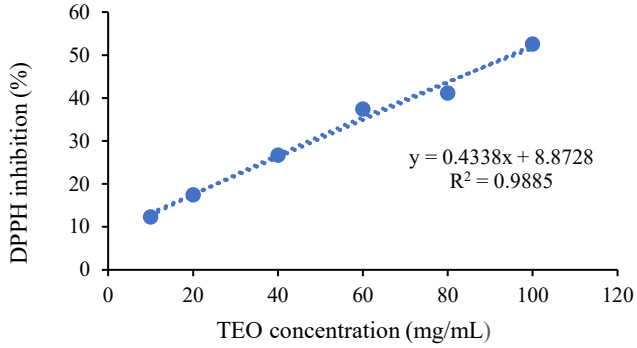

Figure 4. DPPH antioxidant activity of turmeric essential oil

3.5. Antifungal activity of turmeric essential oil

Turmeric essential oil was investigated for its in vitro efficacy against five fungus strains. Figure 4 shows that TEO inhibits the growth of 03/05 examined fungus strains, including *Canida albicans*, *Aspergillus flavus*, and *Fusarium oxysporum*, but not *Malassezia furfur* or *Aspergillus niger*.

The inhibition zone of Turmeric essential oil and Ketoconazole against three fungus strains: *Candida albicans, Aspergillus flavus,* and *Fusarium oxysporum* is shown in Table 3. *Candida albicans* had the smallest antifungal diameter at 8.7 ± 0.6 mm, whereas *Fusarium oxysporum* had the biggest at 21.7 ± 0.5 mm. Ketoconazole (10 µg) was employed as a positive control and showed circular resistance to three fungus species (see Table 3). Turmeric essential oil has a stronger antifungal activity than the positive control, an antibiotic frequently utilized in many infections today.

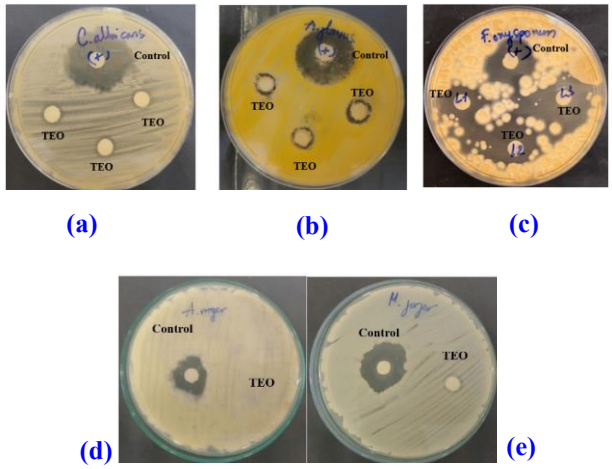

Figure 5. Antifungal activity of turmeric essential oil against five fungi: (a) *C. albicans*, (b) *A.flavus*, (c) *F. oxysporum*, (d) *A.niger*, (e) *M.furfur* by disk diffusion method.

Table 3. Fungal inhibition zone of turmeric essential oil.

No.	Fungi	Inhibition zone (mm)	
		Turmeric oil	Ketoconazole 10µg
1	*Candida albicans*	8.7 ± 0.6	25
2	*Aspergillus flavus*	11.5 ± 1.3	23
3	*Fusarium oxysporum*	21.7 ± 0.5	19

Aspergillus flavus is a widespread contaminant in cereals, legumes, fruit juices, and fresh and dried fruits [23], as well as one of the main producers of aflatoxin in crops and is regarded as the most toxic mold in the world [24]. A study on the antifungal activity of turmeric essential oil revealed that a 0.10% v/v solution of turmeric essential oil was capable of effectively reducing *A. flavus* [25]. Furthermore, germination and sporulation were entirely prevented at a dosage of 0.5% v/v [25].

In contrast to *Aspergillus flavus* and *Fusarium oxysporum*, two forms of fungi that cause plant disease, *Candida albicans* is a fungus that causes disease in humans [26, 27]. *Candida albicans* normally grows in little numbers on your skin, vagina, or mouth. According to research on the antifungal diameter of turmeric essential oil, its significant antifungal activity was 15.67 ± 1.52 mm [6].

Previous research has demonstrated that turmeric essential oil is effective against the fungus *Aspergillus niger*. However, this did not occur with turmeric essential oil derived from Tien Giang turmeric rhizomes. *A. niger* is a fungus that is widely discovered in yogurt, ready-to-drink beverages, and, most notably, bread items. In 2019, a study found that biopolymer films containing turmeric essential oil can protect food goods from fungal attack fiber [8]. The use of polymer not only reduced essential oil evaporation but also improved antifungal properties. In this study, antifungal ability against *Malassezia furfur* fungus was tested. This fungus causes tinea capitis, catheter-associated candidemia, and, on rare occasions, pneumonia. No inhibition zone appeared in this test. The extracted TEO could not inhibit *Malassezia furfur* fungus.

In general, the difference in antifungal activity of turmeric essential oil compared to prior research results is attributable to a difference in the composition of the chemicals in it. This indicates that the extraction efficiency and biological activity of turmeric essential oil are influenced by harvesting, growing methods, and environmental factors.

4. CONCLUSION

Turmeric essential oil was effectively extracted from fresh turmeric rhizomes using hydrodistillation. The highest essential oil content is 5.7% under the following conditions: (1) The material-solvent ratio is 1:4, the Tween 20 concentration is 1500 mg/L, and the extraction time is 120 minutes. The primary components of the essential oil were found to be α-turmerone (16.49%), 7-epi-Sesquithujene (9.0%), α-Santalene (8.17%), β-sesquiphellandrene (7.02%), Teresantalol (6.29), and ar-turmerone (5.85%). In particular, the antioxidant activity was tested using the DPPH method, and the essential oil content was 94.80 mg/mL, capable of blocking 50% of DPPH free radicals and having high antifungal activity against two dangerous fungal strains. *Aspergillus flavus, Fusarium oxysporum*, and *Candida albicans* are plant-borne fungal skin infections that affect humans. As a result, turmeric essential oil holds promise for use in agricultural applications such as insecticides and skin care products.

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TÓM TẮT

THÀNH PHẦN HÓA HỌC VÀ HOẠT TÍNH SINH HỌC CỦA TINH DẦU CHIẾT TỪ CỦ NGHỆ (*Cucurma longa* L.)

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Trong nghiên cứu này, tinh dầu nghệ được chiết từ củ nghệ tươi ở tỉnh Tiền Giang bằng phương pháp chưng cất lôi cuốn hơi nước. Ảnh hưởng của tỷ lệ nguyên liệu/ dung môi, thời gian chiết và nồng độ chất hoạt động bề mặt Tween 20 đến hàm lượng tinh dầu nghệ chiết được khảo sát. Kết quả xác định thành phần hóa học của tinh dầu nghệ bằng GC/MS tìm thấy 50 hợp chất hữu cơ với hàm lượng các chất đặc trưng cho tinh dầu nghệ là α-turmerone (16,49%), 7-epi-Sesquithujene (9,0%), α-Santalene (8,17%), β-sesquiphellandrene (7,02%), Teresantalol (6,29) và ar -turmerone (5,85%). Hoạt tính chống oxy hóa của tinh dầu nghệ được đánh giá bằng phương pháp loại bỏ gốc tự do DPPH, cho giá trị IC50 là 94,80 mg/mL. Hơn nữa, hoạt tính kháng nấm của tinh dầu nghệ được thực hiện bằng phương pháp khuếch tán đĩa thạch với năm chủng nấm: *Malassezia furfur, Canida albicans, Aspergillus flavus, Aspergillus niger* và *Fusarium oxysporum*. Tinh dầu nghệ được phát hiện có khả năng kháng nấm cao đối với *Fusarium oxysporum, Aspergillus flavus* và *Canida albicans,* với đường kính kháng nấm lần lượt là 20 mm, 14 mm và 9 mm. Các kết quả trên cho thấy tinh dầu nghệ có tiềm năng ứng dụng vào thuốc bảo vệ thực vật sinh học và các sản phẩm chăm sóc cá nhân.

Từ khóa: Thuốc bảo vệ thực vật, tinh dầu nghệ, hoạt tính kháng nấm, turmerone, GC/MS.