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**Scientific Research**

**Investigation of chemical composition and antifungal properties of turmeric essential oil (*Curcuma longa* L.)**

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| **ABSTRACT** | **ARTICLE INFO** |
| With the increasing consumer demand for chemical-free food products, the use of medicinal and aromatic plants with high antimicrobial and antioxidant potential has gained considerable attention, influencing the chemical properties of food products. In this study, the chemical compounds, total phenol, and flavonoid content of *Curcuma longa* essential oil were examined. Additionally, the antioxidant properties were assessed using ABTS and DPPH tests, and the antifungal properties of the essential oil were evaluated through disk diffusion, agar well diffusion, MIC and MBC methods. The results from the GC-MS analysis indicated that β-Turmerone was the major compound in the essential oil, accounting for 43.43%. The total phenolic content of the oil was 130.053 mg GAE/g, and the total flavonoid content was 624.5 5 mg QUE/g. The antifungal ability of *Curcuma longa* essential oil was tested against five fungal species: *Aspergillus niger*, *Aspergillus fumigatus*, *Penicillium italicum, Penicillium digitatum*, and *Candida albicans*. The results showed a strong inhibitory effect on *Candida albicans.* *Based on the obtained results, Curcuma longa essential oil can be considered a promising natural preservative as an alternative to chemical preservatives.* | **Article History:**  Received:2024/12/10  Accepted:2025/1/18 |
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**1-Introduction**

One of the primary factors contributing to public health disorders and economic problems is the presence of toxic contamination caused by fungi. Approximately 25% of the total grains consumed globally are affected by fungal contamination, leading to significant destructive losses. Among the various fungal species that contaminate food products, some exhibit higher prevalence, greater destructive potential, and increased resistance to antifungal agents. Notable among these species are Aspergillus and Penicillium [1]. Aspergillus species belong to the group of filamentous fungi and are considered opportunistic pathogens. They are the most common producers of mycotoxins across a wide range of food products. Aflatoxins, which are secondary metabolites produced by various Aspergillus species, are highly mutagenic and toxic, playing a major role in liver contamination and ranking as the primary causative agents of different types of cancer [2]. Currently, synthetic preservatives are widely used to control fungal activity. However, due to the long-term health effects of these preservatives and the rising concern over antimicrobial resistance, their application has been met with widespread dissatisfaction. Consequently, there is an increasing trend toward the utilization of natural compounds to mitigate the harmful effects of fungi. One of the strategies to enhance the shelf life of food products is the use of natural additives and preservatives, such as essential oils and plant extracts, which can prevent the deterioration of food quality and prolong the product's shelf life [3]. Essential oils are complex mixtures of volatile organic compounds with numerous biological and health-promoting properties. Their applications span various industries, including food flavoring, as well as their use in cosmetics, personal care, and pharmaceuticals [4].Turmeric, scientifically known as *Curcuma longa L.*, belongs to the *Zingiberaceae* family, which comprises 53 genera and approximately 1,300 species [5]. This plant is a rich source of various bioactive compounds, including alkaloids, proteins, carbohydrates, phenolic acids, flavonoids, saponins, triterpenoids, esters, and diarylheptanoids [6]. Plants of this species are commonly utilized for the extraction of essential oils, which are rich in monoterpenes and sesquiterpenes that possess antimicrobial, antioxidant, and antifungal properties [7]. The diarylheptanoids present in turmeric are phenolic compounds with low oral bioavailability. Furthermore, 60-70% of turmeric’s composition consists of diferuloylmethan, commonly known as the yellow pigment curcumin, with the molecular formula C₁₂H₂₀O₆. Curcumin itself consists of three derivatives: curcumin, demethoxycurcumin, and bisdemethoxycurcumin, which collectively exhibit polyphenolic characteristics [8]. The objective of this study was to quantify the total phenolic and flavonoid content in turmeric essential oil and to evaluate its free radical scavenging activity using ABTS and DPPH assays. Additionally, the antifungal efficacy of turmeric essential oil was assessed against five fungal species: *Aspergillus niger*, *Aspergillus fumigatus*, *Candida albicans*, *Penicillium italicum*, and *Penicillium digitatum*.

**2- Materials and Methods**

Fresh rhizomes of turmeric were sourced from Ahvaz, and the essential oil was extracted using hydro distillation with a Clevenger apparatus. The related tests on the essential oil were conducted in the laboratories of Agricultural Sciences and Natural Resources University of Khuzestan.

**2.1. Chemical Composition of Turmeric Essential Oil**

The chemical composition of turmeric essential oil was analyzed with GC-MS. The chromatographic system employed capillary columns with a length of 30 meters, an internal diameter of 0.25 mm, and a film thickness of 0.25 μm. Following the Injection of 1 μL of the essential oil, the column temperature was programmed to rise from 45°C to 210°C at a rate of 3°C/min. Finally, the chromatogram and mass spectra were analyzed to identify and quantify the compounds present [9].

**2.2. Determination of Total Phenolic Content of Turmeric Essential Oil**

The Folin–Ciocalteu method was used to determine the total phenolic content. Initially, 1 mL of the essential oil was mixed with 2.5 mL of the Folin reagent and incubated in the dark for 6 minutes. Subsequently, 2.5 mL of 7% sodium carbonate solution was added, and after 60 minutes, the absorbance was measured at 725 nm using a spectrophotometer. A concentration of 1000 ppm of the essential oil in methanol was used for this assay [10].

**2.3. Determination of Total Flavonoid Content of Turmeric Essential Oil**

To determine the total flavonoid content, 1.25 mL of distilled water, 1 mL of turmeric essential oil, and 75 μL of sodium nitrite solution were combined. After 6 minutes, aluminum chloride solution was added, and the mixture was incubated for another 6 minutes. Finally, 1 mL of sodium hydroxide was added, and the absorbance was recorded at 510 nm [11,12].

**2.4. Measurement of DPPH Free Radical Scavenging Activity**

To assess the DPPH free radical scavenging activity, a 1000 ppm solution of the essential oil was prepared, and serial dilutions were made in methanol. Then, 3 mL of the control solution (0.004 g of DPPH powder dissolved in 100 mL of methanol, with an absorbance range of 0.7–0.8) was added to 1 mL of the essential oil. The absorbance was measured at 515 nm against methanol as a blank [11,13].

Inhibition percentage = (Absorbance of control – Absorbance of sample/Absorbance of control)

**2.5. Measurement of ABTS Free Radical Scavenging Activity**

An aqueous solution of 7 mM ABTS (0.0384 g ABTS powder in 10 mL of distilled water) and 2.45 mM potassium persulfate (0.0662 g potassium persulfate in 100 mL of distilled water) were mixed at a 1:2 ratio and incubated in the dark for 16–24 hours. The resulting control solution was diluted with methanol to achieve an absorbance of 0.70 ± 0.02 at 734 nm. Finally, 30 μL of various dilutions of the essential oil were mixed with 3 mL of the prepared solution, and after 6 minutes, the absorbance was measured at 734 nm against methanol as a blank [14].

Inhibition percentage = (Absorbance of control – Absorbance of sample/Absorbance of control)

**2.6. Antifungal Activity of Turmeric Essential Oil**

The antifungal efficacy of turmeric essential oil was evaluated against five fungal strains: *Aspergillus niger*, *Aspergillus fumigatus*, *Candida albicans*, *Penicillium italicum*, and *Penicillium digitatum*, using disc diffusion, well diffusion, minimum inhibitory concentration (MIC), and minimum fungicidal concentration (MFC).

**2.6.1. Disc Diffusion Agar Method**

For the disc diffusion method, blank discs were impregnated with a 512 mg/mL solution of the essential oil for 10 minutes. After performing surface inoculation of the target fungi on sabouraud dextrose agar (SDA), the essential oil-impregnated discs were placed on the plates. Amphotericin B discs were used as the positive control, and blank discs soaked in distilled water were used as the negative control. The plates were incubated at 22–25°C for 48–72 hours [15].

**2.6.2. Well Diffusion Agar Method**

In the well diffusion method, wells of 6 mm diameter were created in SDA plates. After surface inoculation of the target microorganism, 100 μL of the essential oil dilution was added to each well. The plates were incubated at 22–25°C for 48–72 hours [16].

**2.6.3. Minimum Inhibitory Concentration (MIC)**

For MIC determination, Sabouraud dextrose broth (SDB) was used. Serial dilutions of the essential oil (512, 256, 128, …, 1 mg/mL) were prepared, and 100 μL of each dilution was added to the wells. The last two wells served as positive (containing microbial suspension and broth) and negative (containing essential oil and broth) controls. Plates were incubated at 22–25°C for 48–72 hours. The lowest concentration at which no visible growth was observed was recorded as the MIC [17].

**2.6.4. Minimum Fungicidal Concentration (MFC)**

For MFC determination, aliquots from wells showing no visible growth in the MIC test were surface plated onto SDA and incubated at 22–25°C for 48–72 hours. The lowest concentration at which no fungal growth was observed was considered the MFC [18].

**2.7. Statistical Analysis**

The experiment was conducted in a completely randomized design with three replications. Data were analyzed using one-way ANOVA in SPSS software, and Duncan’s multiple range test was applied at a 95% confidence level to compare the means.

**3-Results and Discussion**

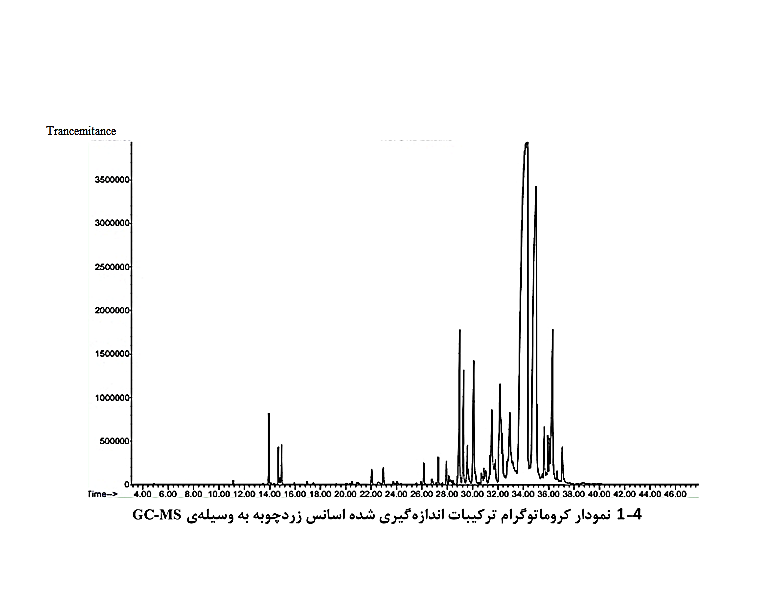
**3.1. Identification of the Chemical Composition of Turmeric Essential Oil**

The *Zingiberaceae* family is rich in monoterpenes and sesquiterpenes, whose proven antibacterial and antifungal properties have led to their frequent use as natural preservatives. Curcuminoids, which belong to the diarylheptanoids group, are the main constituents of the essential oil extracted from turmeric rhizomes. The gas chromatogram of turmeric essential oil is shown in Figure 1.

According to the results obtained from GC-MS analysis, the predominant compound in turmeric essential oil was identified as β-Turmerone, constituting 43.43% of the total composition. The GC-MS results are presented in Table 1. Among the identified compounds, α-Turmerone (23.54%), α-Atlantone (4.54%), α-Curcumene (3.08%), β-Sesquiphellandrene (2.93%), and 2-Phenyl-1-D1-Aziridinebenzene (2.10%) were the most abundant. In the study conducted by Ivanovic et al. (2021), β-Turmerone was reported at a concentration of 25.77%. Additionally, other compounds such as β-Turmerone, β-Sesquiphellandrene, α-Phellandrene, 1,8-Cineole, and β-Bisabolene were also identified as constituents of turmeric essential oil [19].

Among the identified compounds, only 1,8-Cineole and α-Phellandrene belong to the monoterpene group, while the rest are classified as sesquiterpenes. This composition justifies the ratio of 9.26% monoterpenes to 78.29% sesquiterpenes in the essential oil. In contrast, SARAÇ et al. (2024) identified Curlone, Eucalyptol, and 2,4-Dimethylbenzene during the analysis of turmeric essential oil, which differs from the present study’s findings [20]. These variations can be attributed to factors such as plant species, growth conditions, climate, storage methods, drying conditions, soil type, and botanical characteristics [21,22].

**Fig. 1.** Gas chromatography with mass spectrometry turmeric essential oil



**Table 1.** Major chemical composition of turmeric essential oil

|  |  |  |  |
| --- | --- | --- | --- |
| Retention time(min) | Area (%) | Component | number |
| 10.897 | T | α-Thujene |  |
| 11.130 | 0.05 | α -Pinene |  |
| 12.730 | T | Sabinene |  |
| 12.808 | T | β. -Pinene |  |
| 13.052 | T | Ocimene |  |
| 13.463 | 0.03 | β.-Myrcene |  |
| 13.930 | 0.91 | Phellandrene α |  |
| 14.374 | 0.02 | α.-Terpinene |  |
| 14.697 | 0.47 | o-Cymene (o-Cymol) |  |
| 14.830 | 0.09 | β- Phellandrene |  |
| 14.941 | 0.47 | Cineole -1,8 |  |
| 15.574 | T | cis-Ocimene |  |
| 15.930 | 0.03 | γ.-Terpinene |  |
| 16.974 | 0.05 | α.-Terpinolene |  |
| 17.441 | 0.04 | Linalool |  |
| 19.251 | 0.02 | cis-p-Menthan-3-one |  |
| 20.507 | 0.07 | α.-Terpineol |  |
| 22.596 | 0.14 | Geraniol |  |
| 22.962 | 0.5 | Z- Citral |  |
| 23.751 | 0.09 | Thymol |  |
| 24.040 | 0.1 | Carvacrol |  |
| 24.362 | 0.04 | p-Vinyl guaiacol |  |
| 25.584 | 0.04 | p-Eugenol |  |
| 27.295 | 0.38 | trans-Caryophyllene |  |
| 27.628 | 0.04 | α. – Farnesene |  |
| 28.128 | 0.12 | β.-Farnesene |  |
| 28.384 | 3.08 | α.-Curcumene |  |
| 28.817 | 0.25 | γ.-Curcumene |  |
| 29.295 | 1.94 | α.-Zingiberene |  |
| 29.595 | 0.67 | β.-Bisabolene |  |
| 29.672 | 0.31 | α.-Cedrene |  |
| 30.072 | 2.93 | β.-Sesquiphellandrene |  |
| 31.517 | 2.10 | 2-Phenyl-1-D1-Aziridine |  |
| 32.339 | 1.35 | β.-Bisabolene |  |
| 34.216 | 43.43 | β. Tumerone |  |
| 35.005 | 23.54 | α. Tumerone |  |
| 35.916 | 1.18 | ar-Turmerone |  |
| 39.649 | 4.54 | α.-Atlantone |  |

**3.2. Antioxidant Potential of Turmeric Essential Oil**

Polyphenols are secondary metabolites that contain at least one phenolic group in their structure. These compounds are classified as phytochemicals and are known to prevent diseases such as diabetes, cancer, osteoporosis, neurological disorders, and cardiovascular diseases. The phenolic groups in polyphenols exhibit antioxidant activity by donating hydrogen atoms and accepting electrons, thereby disrupting oxidative cycles and preventing diseases such as cancer. The total phenolic content of turmeric essential oil was determined to be 130.053 ± 0.33mg gallic acid per gram, while the total flavonoid content was 624.5 ± 0.043 mg quercetin per gram, which is consistent with the findings of Akter et al. (2019) [23].

To evaluate the antioxidant activity, the free radical scavenging capacities of DPPH and ABTS assays were analyzed, with the results presented in Table 2. The highest DPPH scavenging activity was observed at a concentration of 1000 ppm, reaching 81.52% inhibition. Significant differences were observed among all tested concentrations, indicating an increase in the inhibitory effect of the essential oil with increasing concentration. For the ABTS radical, the lowest inhibition was 27.4% at200 ppm**,** while the highest inhibition was 63.7% at 1000 ppm. Based on the IC50 factor, 50% inhibition of free radicals was achieved at 600 ppm for DPPHand800 ppm for ABTS**.**

Aktar et al. (2019), reported that the DPPH radical scavenging activity was measured as 130.7 ± 2.0 μg/mL for *Curcuma aromatica*, 228.4 ± 3.4 μg/mL for *Curcuma zedoaria*, and 80.4 ± 0.7μg/mLfor *Curcuma longa xanthorrhiza*, with the latter showing a strong similarity to the present study's findings [23]. Khuntia et al. (2023) reported ABTS radical scavenging activity of 10.52 ± 0.02 μg/mL for turmeric leaves and 10.55 ± 0.02 μg/mL for turmeric rhizomes [24]. In contrast, De Carvalho et al. (2020) reported an ABTS radical scavenging capacity of 1490.53 mg ascorbic acid per 100 g, which did not align with the present results [25]. Furthermore, Akinola et al. (2014) examined the DPPH scavenging activity of *Curcuma longa xanthorrhiza*, reporting an IC50 value of 270.1 μg/mL[26].

Curcumin is the principal component of turmeric essential oil, exhibiting polyphenolic properties that contribute to free radical scavenging activity. In addition to, in curcumin, a significant proportion of sesquiterpene compounds such as α-Turmerone and β-Turmerone were identified. Sesquiterpenes or sesquiterpenoids are 15-carbon terpenes similar to monoterpenoids and are widely found in essential oils due to their aromatic nature. Many sesquiterpenoids exhibit antioxidant, phytoalexin, and antimicrobial properties. The presence of α-Turmerone, β-Turmerone, and α-Atlantone, alongside curcumin, as major constituents identified through GC-MS analysis, highlights the strong flavonoid and antioxidant potential of turmeric essential oil.

**Table 2.** Antioxidant activity of turmeric essential oil (DPPH and ABTS assays) a,b

|  |  |  |
| --- | --- | --- |
| Radical scavenging effect (%) |  | Concentration (ppm) |
| ABTS | **DPPH** |  |
| 0. 57a ± 27.40 | 0. 05a ± 29.02 | 200 |
| 0. 20b ± 37.42 | 0. 32b ± 36.52 | 400 |
| 0. 32c ± 42.42 | 0. 47c ± 57.08 | 600 |
| 0. 40d ± 52.44 | 0. 15d ± 72.22 | 800 |
| 0. 35e ± 67.30 | 0. 23e ± 81.52 | 1000 |

The data shown are “mean ± standard deviation” with 3 replace. Different capital letters indicate a significant difference (p<0.05) between the antimicrobial effect of essential oil on pathogens

**3.3. Antifungal Properties of Turmeric Essential Oil**

**3.3.1. Disk Diffusion Agar** **Method**

The antifungal activity of turmeric essential oil is presented in Table 3. According to the results obtained from the disk diffusion agar method, the highest inhibition zone diameter was observed against *Candida albicans*, with a zone of 15.40 mm, indicating the highest susceptibility among the tested fungal species. The lowest inhibitory effect of the essential oil was recorded for Aspergillus species, no significant difference observed between *Aspergillus* *niger* (11.50 mm) and *Aspergillus* *fumigatus* (12.10 mm). Similarly, no significant differences were noted between the Penicillium species, as the inhibition zone for *Penicillium* *italicum* measured 13.20 mm, and for *Penicillium* *digitatum*, it was 13.50 mm. Consequently, it can be concluded that *Candida albicans* was the most sensitive species, while Aspergillus was the most resistant to the essential oil.

Amphotericin B was used as a positive control, producing a minimum inhibition zone of 13.80 mm, which was larger than the maximum inhibition zone caused by the essential oil for all tested fungal species. When the essential oil was used in combination with the antibiotic, an increase in the inhibition zone diameter was observed for all fungal strains.

In a study conducted by Prakash et al. (2012), the effect of turmeric at a concentration of 6 mg/mL on different fungal species using the disk diffusion method resulted in inhibition zones of 11.69 mm for *Aspergillus* *niger*, 15.86 mm for *Aspergillus* *fumigatus*, and 26.76 mm for *Penicillium* *italicum* [28].

Furthermore, in the study by Kasta et al. (2020), the inhibition zone diameters for *Candida* *albicans* were measured at different concentrations (100, 200, 300, 400, and 500 mg/mL) of turmeric rhizome essential oil. resulting in inhibition zones of 10.57 mm, 12.57 mm, 12.52 mm, and 15.22 mm, respectively, confirming the efficacy of the essential oil against *Candida* *albicans* [15].

**Table 3.** Antifungal effect of Amphotericin B antibiotic and interaction with turmeric essential oil

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Interaction**  **result** |  | **Inhibition zone (mm)** | | | | |
| **Interaction** | | **Amphotericin B** | **Turmeric** **essential** **oil** | **Microorganisms** |  |
| Synergy | 14.80 ± 0.57b | | 13.80 ± 0.42b | 11.50 ± 0.48c | Aspergillus niger |  |
| Synergy | 15.40 ± 0.47b | | 14.00 ± 0.35b | 12.10 ± 0.65c | Aspergillus fumigatus |  |
| Synergy | 19.90 ± 0.29a | | 17.80 ± 0.30a | 15.40 ± 0.40a | Candida albicans |  |
| Synergy | 15.00 ± 0.48b | | 14.50 ± 0.39b | 13.20 ± 0.34b | Penicillium italicum |  |
| Synergy | 17.80 ± 0.72c | | 15.00 ± 0.33c | 13.50 ± 0.41b | *Penicillium digitatum* |  |

The data shown are “mean ± standard deviation” with 3 replace. Different capital letters indicate a significant difference (p<0.05) between the antimicrobial effect of essential.

**3.3.2. Well Diffusion Agar** **Method**

The results of the agar well diffusion test are presented in Table 4. The inhibition zone diameters obtained from this method were larger compared to the disk diffusion method. Similar to the disk diffusion method, the highest inhibitory effect of turmeric essential oil was observed against *Candida albicans*, with an average inhibition zone of 17.50 mm. The lowest inhibition effect was recorded for Aspergillus species, with inhibition zones of 12.80 mm for *Aspergillus niger* and 12.90 mm for *Aspergillus fumigatus*, with no significant difference between them. Likewise, the results for *Penicillium italicum* (13.20 mm) and *Penicillium digitatum* (13.50 mm) were closely related and showed no significant differences.

In a study by Senouci et al. (2020), the antifungal effect of turmeric essential oil at concentrations of 100, 200, and 400 mg/mL against *Penicillium expansum* resulted in inhibition zones of 24.1, 35.2, and59.2 mm, respectively, with 100% inhibition achieved at a concentration of 512 mg/mL [16]. Furthermore, in a study by Chauhan et al. (2017), turmeric extract obtained using methanol exhibited inhibition zones of 24 mm against *Aspergillus niger* and 25 mm against *Penicillium cryogenum* using the agar well diffusion method [27]. The inhibition zones for Aspergillus and Penicillium species in these studies differed from the present findings. In this study Penicillium species showing larger inhibition zones compared to Aspergillus.

Turmeric essential oil exhibits lipophilic properties, allowing it to penetrate the cytoplasmic membrane and induce polysaccharide accumulation under dry stress conditions, ultimately leading to plasmolysis in fungal cells. The fungal plasma membrane plays a critical role in maintaining homeostasis, facilitating energy exchange, and regulating genetic information within the cell. Ergosterol, a key component of fungal cell membranes, is responsible for maintaining membrane integrity and function. Natural and synthetic antifungal compounds can disrupt these biological pathways, leading to cell suppression. Turmeric essential oil inhibits the production of ergosterol within fungal cells, disrupting cellular function and ultimately causing cell destruction.

Another mechanism by which antifungal compounds target fungal cells is by inhibiting ATPase and dehydrogenase enzymes. A decrease in ATPase activity in mitochondria leads to a reduction in cellular energy production, lowering intracellular pH and acidifying the environment, which can damage the cell wall and lead to cell death. Turmeric essential oil exerts its antifungal effect by inhibiting succinate dehydrogenase, malate dehydrogenase, and mitochondrial ATPase, while also influencing the relative expression of mycotoxin-related genes, thus disrupting aflatoxin synthesis [1]. Turmeric essential oil also contains saponins, which exhibit antibacterial and antifungal properties. These compounds dissolve cell wall proteins, leading to cytoplasmic leakage and subsequent cell lysis [15].

**Table 4.** Antifungal effect of turmeric essential oil (well diffusion method) a,b

|  |  |
| --- | --- |
| **well diffusion method (mm)** | **Microorganisms** |
| 12.80 ± 0.36c | Aspergillus niger |
| 12.90 ± 0.31c | Aspergillus fumigatus |
| 17.50 ± 0.50a | Candida albicans |
| 14.00 ± 0.26b | Penicillium italicum |
| 14.20 ± 0.39b | *Penicillium digitatum* |

The data shown are “mean ± standard deviation” with 3 replace. Different capital letters indicate a significant difference (p<0.05) between the antimicrobial effect of essential oil on pathogens.

**3.3.3. Minimum Inhibitory Concentration (MIC) and Minimum Fungicidal Concentration (MFC)**

The results of the minimum inhibitory concentration (MIC) and minimum fungicidal concentration (MFC) are presented in Table 5. Among the tested fungal species, *Candida albicans* exhibited the highest sensitivity to turmeric essential oil, with growth inhibition observed at the lowest concentration of 8 mg/mL, while *Aspergillus niger* demonstrated the highest resistance, requiring 64 mg/mL for inhibition. The MFC results were consistent with the MIC values, indicating that the lowest fungicidal concentration was observed for *Candida albicans*, whereas *Aspergillus niger* showed the highest resistance to the essential oil. In a similar study by Chauhan et al. (2017), the MIC values for *Aspergillus niger* and *Penicillium cryogenum* were reported as 400 µL/mL [27]. Additionally, Murugesh et al. (2019) reported MIC and MFC values of 800 µL/mL and 1600 µg/mL, respectively, for *Candida albicans* when exposed to turmeric extract [17]. These findings highlight the potent antifungal activity of turmeric essential oil, particularly against *Candida albicans*, while revealing the relatively higher resistance of *Aspergillus niger*. The variation in MIC and MFC values across different studies may be attributed to differences in the extraction methods, chemical composition of the essential oil, and the fungal strains used in the experiments.

**Table 5.** MIC and MFB of turmeric essential oil

|  |  |  |
| --- | --- | --- |
| **MFB (mg/ml)** | **MIC (mg/ml)** | **Microorganisms** |
| 512 | 64 | *Aspergillus niger* |
| 256 | 32 | *Aspergillus fumigatus* |
| 128 | 8 | *Candida albicans* |
| 256 | 32 | *Penicillium italicum* |
| 256 | 16 | *Penicillium digitatum* |

The data shown are “mean ± standard deviation” with 3 replace. Different capital letters indicate a significant difference (p<0.05) between the antimicrobial effect of essential oil on pathogens

**4-Conclusion**

As discussed, the two primary components of turmeric essential oil are monoterpenes, constituting approximately 9–10%, and sesquiterpenes, accounting for 78–79% of the oil. The key bioactive compound in turmeric essential oil is curcumin, which is primarily responsible for its antimicrobial and antioxidant properties. The free radical scavenging capacities of the essential oil were evaluated, with inhibition percentages of 63.7% for ABTS and 81.52% for DPPH, demonstrating its strong antioxidant potential. The antimicrobial efficacy of turmeric essential oil against five fungal species confirmed its potential to inhibit the growth of the tested microorganisms. The results indicate that turmeric essential oil can be utilized as an effective natural preservative to inhibit the growth of pathogens in food products, thereby enhancing the shelf life and safety of food items.

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**مقاله علمی\_پژوهشی**

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**ترکیبات شیمیایی و خاصیت ضدقارچی اسانس زردچوبه (*L*. *Curcuma longa*)**

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| **تاریخ های مقاله :**  **تاریخ دریافت:20/9/1403**  **تاریخ پذیرش: 29/10/1402** | با افزایش تقاضای مصرف‌کنندگان جهت استفاده از محصولات غذایی فاقد نگهدارنده‌های شیمیایی استفاده از گیاهان دارویی و معطر با پتانسیل ضدمیکروبی و آنتی‌اکسیدانی بالا با تاثیر بر خواص شیمیایی محصولات غذایی رونق فزاینده‌ای را دارا بوده‌اند؛ بنابراین، در این پژوهش ترکیبات شیمیایی، میزان فنل و فلاونوئید کل اسانس زردچوبه مورد بررسی قرار گرفت، همچنین، خاصیت آنتی‌اکسیدانی با استفاده از آزمون‌های ABTS و DPPH و خاصیت ضدقارچی اسانس با استفاده از آزمون‌های دیسک دیفیوژن، چاهک آگار و تعیین حداقل غلظت مهار کنندگی و حداقل غلظت کشندگی بررسی شد. نتایج حاصل از آزمون کروماتوگرافی گازی متصل به طیف‌سنج جرمی نشان داد که β. Tumerone با میزان 43/43 % ترکیب شاخص این اسانس بود. میزان ترکیبات فنول کل این اسانس 053/130 میلی‌گرم گالیک اسید در هرگرم و میزان ترکیبات فلاونوئیدی کل آن برابر با 5/624 میلی‌گرم گالیک اسید در هرگرم کوئرستین مشاهده شد. میزان قابلیت ضدقارچی اسانس زردچوبه بر پنج گونه‌ی قارچی *آسپرژیلوس نایجر*، *آسپرژیلوس فامیگاتوس*، *پنسیلیوم ایتالیکوم*، *پنیسیلیوم دیجیتاتوم* و *کاندیدا آلبیکنز* مورد بررسی قرار گرفت که نتایج نشان دهنده‌ی توانایی خوب اسانس در مهارگونه‌ی *کاندیدا آلبیکنز* بوده است. باتوجه به نتایج به‌دست آمده، اسانس زردچوبه را می‌توان به عنوان یک ماده‌ی نگهدارنده‌ی طبیعی جایگزین مناسب برای نگهدارنده‌های شیمیایی دانست. | |
| **کلمات کلیدی:**  **عامل ضدقارچی،**  **ترکیبات شیمیایی،**  **اسانس زردچوبه** |
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