УЧЕНЫЕ ЗАПИСКИ КАЗАНСКОГО УНИВЕРСИТЕТА.
СЕРИЯ ЕСТЕСТВЕННЫЕ НАУКИ

2022, Т. 164, кн. 1
С. 36–45

ISSN 2542-064X (Print)
ISSN 2500-218X (Online)

ORIGINAL ARTICLE

UDC 543.8:615.322

doi: 10.26907/2542-064X.2022.1.36-45

# PHYSICOCHEMICAL PROPERTIES, CHEMICAL COMPONENTS, AND ANTIBACTERIAL ACTIVITY OF THE ESSENTIAL OIL FROM *Mentha arvensis* L. LEAVES

*L.P.T. Quoc*

*Institute of Biotechnology and Food Technology, Industrial University of Ho Chi Minh City, Ho Chi Minh City, 700000 Vietnam*

**Abstract**

Essential oil (EO) obtained from *Mentha arvensis* L. leaves was separated by the steam distillation method. The following EO physicochemical properties were analyzed: acid value, saponification value, ester value, relative density, absolute density, and freezing point. Using gas chromatography-mass spectrometry, 26 major compounds were detected in the EO, with menthol having the highest level (69.44%). The antioxidant capacity of the EO ($IC_{50}$ = 330 mg $mL^{-1}$) was determined with the help of the DPPH (2,2-diphenyl-1-picrylhydrazyl) assay. The antibacterial activity (against *Salmonella enteritidis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli*) was assessed using the paper disc diffusion method for antibiotic susceptibility testing.

**Keywords:** antibacterial activity, antioxidant capacity, *Mentha arvensis* L., menthol, herb

## Introduction

*Mentha arvensis* L. is a flowering and strongly aromatic herb species from the family Lamiaceae (commonly known as corn mint, field mint, or wild mint). It has been cultivated widely throughout the world, especially in Europe, western and central Asia, eastern Siberia, etc. [1]. In Vietnam, it occurs naturally in the Mekong River delta, as well as in the provinces of Binh Thuan, Lao Cai, Quang Nam, Lam Dong, Khanh Hoa, etc. [2].

Historically, *M. arvensis* L. has been extensively used as a household remedy and a spice. Nowadays, it is also an important industrial plant grown to produce food (juices, candies, and cakes), cosmetics (perfume), and pharmaceuticals (various drugs) [1, 3]. As far as the latter is concerned, many previous studies have reported that *M. arvensis* L. has an outstanding medicinal potential for treating stomach problems, allergy, liver and spleen diseases, asthma and jaundice, etc. [4, 5].

*M. arvensis* L. owes its medicinal efficacy to the specific chemical components of the essential oil (EO) extracted from its leaves: this EO contains many bioactive (menthol, isomenthone, *p*-cymene, limonene, caryophyllene, α-pinene, etc. [6]) and phenolic (rosmarinic acid [7] and hesperidin [8]) compounds. However, the quantity of these compounds is significantly influenced by various factors, such as the season, climate, genes, maturity stage, and extraction method.

To recover these precious compounds, the EO can be extracted using various methods, such as supercritical fluid extraction, hydrodistillation, steam distillation, solvent extraction, etc. Among them, steam distillation is applied more widely on an industrial scale [9]. Depending on the extraction method and the type of raw material, the EO obtained will possess different chemical constituents, antioxidant capacity (AC), antibacterial activity (AA), and physicochemical properties. In Khanh Hoa province, *M. arvensis* L. has been especially widely cultivated in recent years with a high output, with local citizens using it as a food seasoning and medicated oil. Nevertheless, until now, to the best of my knowledge, none of the above-mentioned chemical characteristics have been studied for this material from Khanh Hoa province. Therefore, the major aim of this study was to assess the chemical composition and the general quality of the *M. arvensis* L. EO from Khanh Hoa province.

## 1. Material and Methods

**1.1. Plant material**. The EO from the leaves of *M. arvensis* L. (Khanh Hoa province, Vietnam) was extracted by steam distillation and stored at 4 °C in a dark glass bottle, without being exposed to direct sunlight, until required for the experiment.

**1.2. Bacterial strains**. The bacterial strains used in this study include *S. aureus* (ATCC 25923), *S. enteritidis* (ATCC 13076), *E. coli* (ATCC 25922), and *P. aeruginosa* (ATCC 27853), all provided by the Institute of Biotechnology and Food Technology, Industrial University of Ho Chi Minh City (Vietnam).

**1.3. Determination of the EO physical properties.** The relative density (RD), absolute density (AD), and freezing point (FP) were determined according to ISO 279:1998 and ISO 1041:1973 [10, 11].

**1.4. Determination of the acid value (AV) of the EO.** According to Quoc [12], 1 g of the EO was dissolved in 5 mL of 96% alcohol, and a few drops of 1% phenolphthalein solution were then added. The mixture obtained was titrated using 0.1 N KOH solution (diluted in 96% ethanol) until a pale pink color appeared for 30 sec:

$$AV = \frac{V_{\mathrm{KOH}} \cdot 0.1 \cdot 56.1}{\text{Mass of essential oil}}.$$

**1.5. Determination of the saponification value (SV) of the EO.** The SV value was measured as described by Quoc [12] with minor modifications. Initially, 2 g of the EO was dissolved in 25 mL of 0.5 N KOH solution (diluted in 96% ethanol). The mixture was then heated in a water bath for 1 h, and then 25 mL of distilled water and a few drops of 1% phenolphthalein solution were added. The final solution was titrated with 0.5 N HCl solution until the pink color disappeared:

$$SV = \frac{(V_{\mathrm{blank}} - V_{\mathrm{sample}}) \cdot 0.5 \cdot 56.1}{\text{Mass of essential oil}}.$$

The ester value (EV) was determined based on the AV and SV, using the following formula: $ES = SV - AV$.

**1.6. Determination of the antioxidant capacity (AC) of the EO.** The AC of the EO to scavenge DPPH (2,2-diphenyl-1-picrylhydrazyl) free radicals was determined

according to the method of Kirby and Schmidt [13], with some small changes. The EO was dissolved in ethanol (96%, v/v) to obtain its various concentrations (1024, 512, 256, 128, and 64 mg $mL^{-1}$). Then, 0.3 mL of the obtained solution was mixed with 2.7 mL of DPPH in ethanol solution (concentration of 40 μg $mL^{-1}$) and kept in the dark for 30 min at room temperature. The AC was recorded by observing the decrease in absorbance at 517 nm against a control sample (containing only DPPH solution without the tested sample). Ascorbic acid was used as a standard to compare with the AC of the EO. The percent inhibition was plotted against the EO concentrations to estimate the concentration providing 50% inhibition ($IC_{50}$). The AC was evaluated using the formula below:

$$\% \text{ inhibition} = \frac{\text{Absorbance of control} - \text{Absorbance of sample}}{\text{Absorbance of control}} \times 100.$$

**1.7. Determination of the antibacterial activity (AA) of the EO.** The AA of the EO was determined using the paper disc diffusion method described by Bauer et al. [14]. Briefly, 100 μL of bacterial suspension (0.5 McFarland standard, approximately $1.5 \cdot 10^8$ CFU $mL^{-1}$) were spread on MHA media (Mueller-Hinton agar) using a sterile hockey stick. Then, the sterile paper discs (6 mm in diameter) were impregnated with 5 μL of the EO. Gentamicin (10 μg $disc^{-1}$) and dimethylsulfoxide (DMSO) solution (5%, v/v) were used as positive and negative controls, respectively. Finally, all dishes were incubated for 24 h at 37 °C and the AA was assessed by inhibitory zone with the paper disc of 6 mm in diameter.

**1.8. Gas chromatography-mass spectrometry (GC-MS) analysis.** The chemical composition of the EO was analyzed using the GC-MS method: 1 μL of the EO was injected into a gas chromatograph (Agilent HP 6890N, USA) with a capillary column (HP-5ms, 30 m × 0.25 mm × 0.45 μm, Agilent Technologies, USA) equipped with a quadrupole mass analyzer (Agilent HP 5972, USA). Helium was used as a carrier gas at a constant flow rate of 0.5 mL $min^{-1}$ and a split ratio of 10:1. The injection temperature was 250 °C, and the temperature program was set as follows: initial temperature of 50 °C, held for 2 min, increased to 300 °C at a rate of 10 °C $min^{-1}$, and held for 5 min. Mass spectra were recorded at the ionization energy of 70 eV in the EI mode.

**1.9. Statistical data analysis.** All experiments were performed in triplicate. The results were expressed as mean ± standard deviation (SD). The one-way analysis of variance (ANOVA) with Fisher's least significant difference (LSD) procedure was carried out to test significant differences between the means ($p < 0.05$). The data were analyzed using Statgraphics Centurion XV software (version 15.1.02, Statgraphics Technologies, Inc., USA).

## 2. Results and Discussion

**2.1. Physicochemical properties of the EO from *M. arvensis* L. leaves.** Table 1 shows the physicochemical properties of the EO extracted from *M. arvensis* L. leaves. The RD of the obtained EO is similar to that of the *M. arvensis* L. EO from Brazil (0.897) and lower than that of the *M. piperita* EO (0.901) from Brazil [15].

Table 1. Physicochemical properties of the EO from *M. arvensis* L. leaves

| No. | Physicochemical properties | Value |
|---|---|---|
| 1 | Absolute density (AD, g $mL^{-1}$) | 0.8959 ± 0.0001 |
| 2 | Relative density (RD) | 0.8987 ± 0.0003 |
| 3 | pH | 4.670 ± 0.006 |
| 4 | Freezing point (FP, °C) | –7.33 ± 0.58 |
| 5 | Acid value (AV, mg KOH $g^{-1}$ EO) | 1.171 ± 0.009 |
| 6 | Saponification value (SV, mg KOH $g^{-1}$ EO) | 25.970 ± 0.007 |
| 7 | Ester value (EV, mg KOH $g^{-1}$ EO) | 24.799 ± 0.001 |

The RD is also higher than that of the EO of *Ageratum conyzoides* L. leaves (0.889) [12]. Essentially, the RD and AD values strongly correlate with each other and depend on the surrounding temperature. In general, ADs of most EOs from plants are lower than that of water: for instance, the *M. arvensis* L. EO in the present study – 0.8959 g $mL^{-1}$, the *Ceratonia siliqua* pulp and seed EOs – 0.833 and 0.91 g $mL^{-1}$, respectively [16]. In addition, the pH value of the EO from *M. arvensis* L. leaves is quite low (pH 4.67), which is in agreement with many EOs extracted from various plants, such as *A. conyzoides* leaves (pH 4.46), *M. piperita* (pH 5.2) [12, 15], etc. This can be explained by the strong dependence of the EO physicochemical properties on the natural source of the plant and the EO chemical composition.

Remarkable variations in FP were found between various EOs in previous studies [12, 17]. The FP of the EO in the present study is quite low (–7.33 °C), but this value cannot be compared with any other because there are no published reports on the FP of EOs of this plant, except those by Abdul-Majeed et al. [18] and Quoc [12] for the FP of EOs extracted from *Eucalyptus camaldulensis* Dehnh. leaves (0–1 °C) and *A. conyzoides* leaves (–10.33 °C). In the above cases, the differences in the FP values of EOs from plants were attributed to the influence of major components in these EOs, i.e., menthol, menthone, and isomenthone.

The AV and SV of the *M. arvensis* EO were found to be 1.171 and 25.97 mg KOH $g^{-1}$ EO, respectively. They were lower than those of basil (AV – 3.95 mg KOH $g^{-1}$ EO; SV – 198 mg KOH $g^{-1}$ EO) and lemongrass (AV – 4.09 mg KOH $g^{-1}$ EO; SV – 143 mg KOH $g^{-1}$ EO) EOs [19]. The EV obtained from the AV and SV is only 24.799 mg KOH $g^{-1}$ EO, which is slightly smaller than that of the *C. siliqua* pulp and seeds EO (42.61 and 33.22 mg KOH $g^{-1}$ EO, respectively) [16]. As yet, there are few published studies on the AV, SV, and EV of the *M. arvensis* L. EO; however, the AV and EV of the EO from *M. arvensis* L. collected from Andhra Pradesh state (India) were 1.33 and 27.64 mg KOH $g^{-1}$ EO, respectively [20] and are similar to those of our study. According to Quoc [12], distillation techniques, climatic conditions, plant varieties, regions, harvest periods, genotype, type of material, and chemical composition directly affect all these parameters.

**2.2. Chemical composition of the EO from *M. arvensis* L. leaves.** The chemical composition of the EO from *M. arvensis* L. leaves was determined by GC-MS. A total of 26 compounds were identified and quantified in the EO isolated from the *M. arvensis* L. leaves; they constituted 98% of the oil and were tested by retention times ranging from 6.29 to 21.8 min (Table 2). The EO was found to contain menthol (69.44%), menthone (7.66%), isomenthone (5.65%), and trans-carane (4.34%) as major compounds.

Table 2. Chemical composition of the EO from *M. arvensis* L. leaves

| No. | Compound | RT (min) | (%) |
|---|---|---|---|
| 1 | Diacetone alcohol | 6.29 | 1.94 |
| 2 | α-pinene | 8.57 | 0.52 |
| 3 | Sabinene | 9.56 | 0.23 |
| 4 | L-β-pinene | 9.68 | 0.59 |
| 5 | β-myrcene | 9.92 | 0.32 |
| 6 | 3-octanol | 10 | 0.22 |
| 7 | *o*-xylene, 4-ethyl- | 10.84 | 0.06 |
| 8 | D-limonene | 10.96 | 2.35 |
| 9 | 1,8-cineole | 11.06 | 0.13 |
| 10 | Isopulegol | 13.97 | 0.43 |
| 11 | Menthone | 14.19 | 7.66 |
| 12 | Isomenthone | 14.45 | 5.65 |
| 13 | Menthol | 14.77 | 69.44 |
| 14 | Neomenthol | 14.96 | 1.28 |
| 15 | Levomenthol | 15.11 | 1.87 |
| 16 | *n*-valeric acid cis-3-hexenyl ester | 16.03 | 0.48 |
| 17 | Pulegone | 16.27 | 0.65 |
| 18 | Piperitone | 16.63 | 0.58 |
| 19 | (+)-3-menthene | 17.04 | 0.08 |
| 20 | trans-carane | 17.49 | 4.34 |
| 21 | 3-menthene | 17.87 | 0.11 |
| 22 | (–)-β-bourbonene | 19.73 | 0.12 |
| 23 | Decyl acetate | 19.94 | 0.07 |
| 24 | Caryophyllene | 20.51 | 0.46 |
| 25 | 3,3,6-trimethyl-1,4-heptadien-6-ol | 21.48 | 0.17 |
| 26 | D-germacrene | 21.8 | 0.23 |

In addition, the obtained results revealed that the terpene group also appears in the EO (in small amount, including α-pinene, limonene, 3-menthene, sabinene, etc. Significant variations were observed in the chemical profile of the *M. arvensis* L. EO: for instance, menthol, *p*-menthone, isomenthone, and neo-menthol of the EO of *M. arvensis* L. aerial parts from India account for 71.40%, 8.04%, 5.42%, and 3.18%, respectively [21], while the EO of *M. arvensis* L. leaves from the southeastern region of Macedonia contained menthol (32.47%), isomenthone (15.97%), 1,8-cineol (5.4%), and neomenthol (5.24%) [6].

Principally, menthol is a major component of the EO, accounting for a high proportion in the flower, leaves, and whole plant of *M. arvensis* L. [6]. According to Ribeiro-Santos et al. [22], the chemical composition of EOs is significantly influenced by different factors, such as the development stage, variety, geographical origin, part of the plant used, age, season and condition of the plant when harvested, as well as the extraction method, analysis conditions, and the solvent used.

The findings of this study show that menthol is present in the EO extracted from *M. arvensis* L. leaves in Vietnam in an amount similar to or higher than that of EOs from elsewhere, confirming that this compound is precious and can be widely used in the food and pharmaceutical industries.

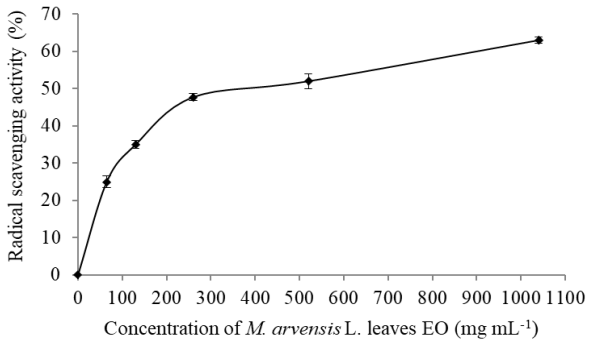


Fig. 1. Radical scavenging activity of the EO from *M. arvensis* L. leaves

**2.3. Antioxidant capacity (AC) of the EO from *M. arvensis* L. leaves.** As seen in Fig. 1, the AC value of the EO significantly increased with a rise in the EO concentration (up to 1024 mg $mL^{-1}$) (Fig. 1). The $IC_{50}$ of the EO was 330 mg $mL^{-1}$, while that of the control sample (Vitamin C) was only 15.25 μg $mL^{-1}$. These estimates prove that the AC of the EO is significantly lower than that of the control sample and the EO of *M. arvensis* L. from Brazil ($IC_{50}$ = 26.72 mg $mL^{-1}$) [8]. Compared to other EOs isolated from various materials, the AC in this study is also lower than that of the EO of *A. conyzoides* leaves ($IC_{50}$ = 8 mg $mL^{-1}$) [12], *C. siliqua* pulp ($IC_{50}$ = 7.8 μg $mL^{-1}$), and *C. siliqua* seeds ($IC_{50}$ = 31.25 μg $mL^{-1}$) [16]. Almost all plant EOs possess AC; however, it depends strongly on the chemical composition of the EO or the synergistic effect of its compounds. In this study, most major and minor compounds in the EO possessed AC, such as menthol [23], menthone [24], α-pinene, and 1,8-cineole [25], which is advantageous for using the EO from *M. arvensis* L. in food production.

**2.4. Antibacterial activity (AA) of the EO from *M. arvensis* L. leaves.** The EO from *M. arvensis* L. leaves shows AA against four bacterial strains (Table 3). The inhibition zones of the positive control, listed in susceptible order, are *S. aureus* > *S. enteritidis* > *P. aeruginosa* > *E. coli*, while those of the EO, arranged in susceptible order, are *S. enteritidis* > *S. aureus* > *P. aeruginosa* > *E. coli*. The obtained results demonstrate that the AA of the EO is stronger than that of the positive control for *S. enteritidis*.

Table 3. Antibacterial zones of the EO from *M. arvensis* leaves

| No. | Bacterial strains | Inhibition zones of gentamycin, mm | Inhibition zones of EO, mm |
|---|---|---|---|
| 1 | *S. enteritidis* | $18.0 \pm 0.71^{Ab}$ | $22.8 \pm 0.85^{Bc}$ |
| 2 | *S. aureus* | $25.3 \pm 0.65^{Bc}$ | $21.2 \pm 0.95^{Ab}$ |
| 3 | *E. coli* | $15.3 \pm 0.65^{Ba}$ | $11.9 \pm 0.88^{Aa}$ |
| 4 | *P. aeruginosa* | $16.3 \pm 0.6^{Ba}$ | $12.0 \pm 0.40^{Aa}$ |

Different lowercase letters in the same column denote significant differences ($p$<0.05) with respect to the types of bacterial strains.

Different capital letters in the same row denote significant differences ($p$<0.05) with respect to the antibacterial agents.

According to Nazim et al. [26], the EO from *M. arvensis* L. leaves also inhibited the growth of both Gram-positive (*S. aureus*, *B. subtilis*, and *Streptococcus pyogenes*) and Gram-negative (*E. coli* and *P. aeruginosa*) bacteria, and these results are

in agreement with those of our study. In addition, Pandey et al. [21] used the disc diffusion method to demonstrate that the EO extracted from *M. arvensis* L. leaves exhibited *in vitro* efficacy against human pathogenic fungi, such as *Fusarium oxysporum* and *Trichophyton mentagrophytes*. Many previous studies have reported that the AA of EOs depends on the chemical constituents and their concentration. According to Mihajlov et al. [6], some compounds contained in EOs such as menthol, menthone, 1,8-cineole, limonene, and caryophyllene, can effectively act against Gram-positive (*S. aureus* and *Enterococcus faecalis*) and Gram-negative (*E. coli*, *P. aeruginosa*, *Proteus vulgaris*, *Klebsiella pneumonia*, and *Salmonella* sp.) bacteria. Therefore, the results discussed in this article are in good correlation with those published in the literature.

## Conclusions

Our observations suggest that Khanh Hoa province has great potential for the commercial production of the high-quality EO from *M. arvensis* L. leaves rich in menthol, menthone, and isomenthone. Notably, the EO from the *Mentha* plant native to the region under study is characterized by high AA and AC. The physicochemical properties of this EO are also beneficial. The data obtained could be helpful in further research on using EOs, in particular those from *M. arvensis* L. of Khanh Hoa province, for medicinal or pharmaceutical purposes.

**Acknowledgments.** This research was performed at the Institute of Biotechnology and Food Technology, Industrial University of Ho Chi Minh City (Vietnam). The author would like to thank Nguyen Thuy Tien, Tran Thi My Linh, and Nguyen Thi Thanh Ni for their helpful advice on various technical issues covered in this article.

### References

1. Thawkar B.S., Jawarkar A.G., Kalamkar P.V., Pawar K.P., Kale M.K. Phytochemical and pharmacological review of *Mentha arvensis*. *Int. J. Green Pharm.*, 2016, vol. 10, no. 2, pp. 71–76.
2. Phuc T.B., Hau N.C. Investigation and assessment of the quality of Japanese mint essential oil (*Mentha arvensis*) originated from various geographical regions in Vietnam. *J. Sci. Technol. – NTTU*, 2020, vol. 3, no. 4, pp. 19–24. doi: 10.55401/jst.v3i4.222.
3. Mamadalieva N.Z., Hussain H., Xiao J. Recent advances in genus *Mentha*: Phytochemistry, antimicrobial effects, and food applications. *Food Front.*, 2020, vol. 1, no. 4, pp. 435–458. doi: 10.1002/fft2.53.
4. Jagetia G.C., Baliga M.S. Influence of the leaf extractof *Mentha arvensis* Linn. (mint) on the survival of mice exposed to different doses of gamma radiation. *Strahlenther. Onkol.*, 2002, vol. 178, no. 2, pp. 91–98. doi: 10.1007/s00066-002-0841-y.
5. Khan S.W., Khatoon S. Ethnanobotanical studies on some useful herbs of Haramosh and Bugrote Valleys in Gilgit, northern areas of Pakistan. *Pak. J. Bot.*, 2008, vol. 40, no. 1, pp. 43–58.
6. Mihajlov Lj., Kostadinović Veličkovska S., Naumova Letia G., Podea P.V., Mirhosseini H. Isolation, chemical composition, antioxidant and antimicrobial potential of essential oil from *Mentha arvensis* L. organically planted from Macedonia. *Riv. Ital. Sostanze Grasse*, 2019, vol. 96, no. 3, pp. 151–160.
7. Salin O., Törmäkangas L., Leinonen M., Saario M., Hagström M., Ketola R.A., Saikku P., Vuorela H., Vourela P.M. Corn mint (*Mentha arvensis*) extract diminishes acute *Chlamydia*

*pneumoniae* infection in vitro and in vivo. *J. Agric. Food Chem.*, 2011, vol. 59, no. 24, pp. 12836–12842. doi: 10.1021/jf2032473.

8. Nilo M.C.S., Riachi L.G., Simas D.L.R., Coelho G.C., da Silva A.J.R., Costa D.C.M., Alviano D.S, Alviano C.S., De Maria C.A.B. Chemical composition and antioxidant and antifungal properties of *Mentha piperita* L. (peppermint) and *Mentha arvensis* L. (cornmint) samples. *Food Res.*, 2017, vol. 1, no. 5, pp. 147–156. doi: 10.26656/fr.2017.5.104.
9. Machado C.A.T., Lepikson H.A., de Andrade M.A.N. Essential oil steam distillation: Manufacturing 4.0. *J. Bioeng. Technol. Appl. Health*, 2021, vol. 4, no. 3, pp. 95–99. doi: 10.34178/jbth.v4i3.170.
10. ISO 279:1998. Essential oils – determination of relative density at 20$^{o}$C. Geneva, Switzerland, Int. Organ. Stand., 1998.
11. ISO 1041:1973. Essential oils – determination of freezing point. Geneva, Switzerland, Int. Organ. Stand., 1973.
12. Quoc L.P.T. Physicochemical properties and antibacterial activity of essential oil of *Ageratum conyzoides* L. leaves. *Agric. Conspec. Sci.*, 2020, vol. 85, no. 2, pp. 139–144.
13. Kirby A.J., Schmidt R.J. The antioxidant activity of Chinese herbs for eczema and of placebo herbs. *J. Ethnopharmacol.*, 1997, vol. 56, no. 2, pp. 103–108. doi: 10.1016/S0378-8741(97)01510-9.
14. Bauer A.W., Kirby W.M.M., Sherris J.C., Turck M. Antibiotic susceptibility testing by a standardized single disk method. *Am. J. Clin. Pathol.*, 1966, vol. 45, no. 4, pp. 493–496. doi: 10.1093/ajcp/45.4_ts.493.
15. de Souza Guedes J.P., de Souza E.L. Investigation of damage to *Escherichia coli*, *Listeria monocytogenes* and *Salmonella* Enteritidis exposed to *Mentha arvensis* L. and *M. piperita* L. essential oils in pineapple and mango juice by flow cytometry. *Food Microbiol.*, 2018, vol. 76, pp. 564–571. doi: 10.1016/j.fm.2017.09.020.
16. Ouis N., Hariri A. Antioxidant and antibacterial activities of the essential oils of *Ceratonia siliqua*. *Banat's J. Biotechnol.*, 2018, vol. IX, no. 17, pp. 13–23. doi: 10.7904/2068-4738-IX(17)-13.
17. Quoc L.P.T. Physicochemical properties, chemical components, and antibacterial activity of *Melaleuca cajuputi* Powell essential oil leaves from quang tri province, Vietnam. *Bull. Chem. Soc. Ethiop.*, 2021, vol. 35, no. 3, pp. 677–683. doi: 10.4314/bcse.v35i3.18.
18. Abdul-Majeed B.A., Hassan A.A., Kurji B.M. Extraction of oil from *Eucalyptus camaldulensis* using water distillation method. *Iraqi J. Chem. Pet. Eng.*, 2013, vol. 14, no. 2, pp. 7–12.
19. Mustapha A. Comparative analysis on the extraction of essential oil from lemongrass and basil leaves. *Int. J. Innovative Sci. Eng. Technol.*, 2018, vol. 5, no. 11, pp. 114–118.
20. Rao B.R.R. Biomass and essential oil yields of cornmint (*Mentha arvensis* L. f. *piperascens* Malinvaud *ex* Holmes) planted in different months in semi-arid tropical climate. *Ind. Crops Prod.*, 1999, vol. 10, no. 2, pp. 107–113. doi: 10.1016/S0926-6690(99)00012-6.
21. Pandey A.K., Rai M.K., Acharya D. Chemical composition and antimycotic activity of the essential oils of corn mint (*Mentha arvensis*) and lemon grass (*Cymbopogon flexuosus*) against human pathogenic fungi. *Pharm. Biol.*, 2003, vol. 41, no. 6, pp. 421–425. doi: 10.1076/phbi.41.6.421.17825.
22. Ribeiro-Santos R., Andrade M., de Melo N.R., Sanches-Silva A. Use of essential oils in active food packaging: Recent advances and future trends. *Trends Food Sci. Technol.*, 2017, vol. 61, pp. 132–140. doi: 10.1016/j.tifs.2016.11.021.
23. Mesbahzadeh B., Garmsiri M., Jalalvand F., Shojaie L., Kakar M.A. Oral administation of menthol alleviate adverse effects of polycystc ovarian syndrome on blood biochemical

parameters and antioxidant status in Wister rats. *GMJ Med.*, 2017, vol. 1, no. 1, pp. 9–14. doi: 10.29088/GMJM.2017.09.

24. Derwich E., Chabir R., Taouil R., Senhaji O. *In-vitro* antioxidant activity and GC/MS studies on the leaves of *Mentha piperita* (Lamiaceae) from Morocco. *Int. J. Pharm. Sci. Drug Res.*, 2011, vol. 3, no. 2, pp. 130–136.
25. Dowom S.A., Abrishamchi P., Asili J. Essential oil (EO) composition and antioxidant activity of two *Salvia leriifolia* Benth. (Lamiaceae) populations from Iran. *N. Biol. Reperta*, 2016, vol. 3, no. 2, pp. 108–117. doi: 10.21859/acadpub.nbr.3.2.108.
26. Nazim M., Sadiq Q.-U.-A., Nawaz A., Anjum S., Ali M., Maryam H. *Mentha arvensis*, a medicinal and aromatic plant, has high nutritional value and several-uses: A review. *Bul. Agroteknol.*, 2020, vol. 1, no. 2, pp. 37–49. doi: 10.32663/ba.v1i2.1180.

Received
December 8, 2021

**Le Pham Tan Quoc**, PhD in Food Science and Technology, Lecturer

Institute of Biotechnology and Food Technology, Industrial University of Ho Chi Minh City
Ward 4, Go Vap District, Ho Chi Minh City, 700000 Vietnam
E-mail: *lephamtanquoc@iuh.edu.vn*

ОРИГИНАЛЬНАЯ СТАТЬЯ

УДК 543.8:615.322 doi: 10.26907/2542-064X.2022.1.36-45

## Физико-химические свойства, химические компоненты и антибактериальная активность эфирного масла из листьев *Mentha arvensis* L.

*Л.Ф.Т. Куок*

*Институт биотехнологий и пищевых технологий, Промышленный университет Хошимина, г. Хошимин, 700000, Вьетнам*

**Аннотация**

Эфирное масло (ЭМ) из листьев *Mentha arvensis* L. получено методом паровой дистилляции и проанализировано по следующим физико-химическим свойствам: кислотное число, число омыления, эфирное число, относительная и абсолютная плотность и температура замерзания. С помощью газовой хроматографии-масс-спектрометрии в ЭМ было обнаружено 26 основных соединений, при этом содержание ментола было самым высоким (69.44%). Показано, что выделенное ЭМ обладает антиоксидантной емкостью ($IC_{50}$ = 330 мг/мл) по реакции с ДФПГ (2,2-дифенил-1-пикрилгидразилом) и антибактериальной активностью (относительно *Salmonella enteritidis, Staphylococcus aureus, Pseudomonas aeruginosa* и *Escherichia coli*) по методу диффузии на бумажном диске для определения чувствительности к антибиотикам.

**Ключевые слова:** антибактериальная активность, антиоксидантная способность, *Mentha arvensis* L., ментол, растительное сырье

**Благодарности.** Исследование выполнено на базе Института биотехнологий и пищевых технологий Промышленного университета Хошимина (Вьетнам). Автор выражает искреннюю благодарность коллегам Нгуен Тхюи Чанг, Тран Тхи Ми Линь и Нгуен Тхи Тхань Ни за ценные рекомендации относительно ряда технических вопросов, рассматриваемых в настоящей статье.

Поступила в редакцию
08.12.2021

**Ле Фам Тан Куок**, доктор философии в области наук о продуктах питания и их производстве, преподаватель

Институт биотехнологий и пищевых технологий, Промышленный университет Хошимина
р-н. 4, г.о. Го Вап, г. Хошимин, 700000, Вьетнам
E-mail: *lephamtanquoc@iuh.edu.vn*

***For citation*:** Quoc L.P.T. Physicochemical properties, chemical components, and antibacterial activity of the essential oil from *Mentha arvensis* L. leaves. *Uchenye Zapiski Kazanskogo Universiteta. Seriya Estestvennye Nauki*, 2022, vol. 164, no. 1, pp. 36–45. doi: 10.26907/2542-064X.2022.1.36-45.

***Для цитирования*:** *Quoc L.P.T.* Physicochemical properties, chemical components, and antibacterial activity of the essential oil from *Mentha arvensis* L. leaves // Учен. зап. Казан. ун-та. Сер. Естеств. науки. – 2022. – Т. 164, кн. 1. – С. 36–45. – doi: 10.26907/2542-064X.2022.1.36-45.