Volume: 4 **Issue: 1**
Year: 2023
DOI: 10.53811/ijtcmr.1233624

International Journal of Traditional and Complementary Medicine Research

Publisher
Duzce University

ORIGINAL RESEARCH

Antioxidant, Antimicrobial and Phenolic Component Analysis of Some Edge Medicinal Plants

Sultan Ulger[1], Serpil Ugras[2]*

[1]Department of Chemistry, Duzce University, Institute of Science, 81620, Duzce, Türkiye
[2]Department of Biology, Duzce University, Faculty of Science and Art, 81620, Duzce, Türkiye

* Corresponding Author: Serpil Ugras, e-mail: serpilkus@gmail.com

Received: 13.01.2023 Accepted: 24.03.2023

Abstract
Objective: The plants, which grow wild in the Eastern Anatolia Region and are known as kari (*Arum elongatum*; *Ae*) and mende (*Chaerophyllum macrospermum*; *Cm*), are used for treatment purposes such as pain reliever and wound healing properties. It is aimed to determine some biological properties of these plants, which are also used medicinally.
Material-Method: Firstly, hexane (H), ethanol (E) and acetone (A) extracts of dried plants were prepared and antimicrobial activities of extracts against 13 indicator microorganisms were determined by agar well diffusion method. Antioxidant activities were determined by DPPH and ABTS analyses and the total phenolic component contents were determined by the Folin-Ciocalteu method.
Results: The maximum extract yield was obtained in the ethanol extracts of the plants (*Ae*E;10.4011% *Cm*E;2.4898%), the minimum extract yield was obtained in the acetone extracts (*Ae*A;0.8422% *Cm*A;0.3510%). The hexane extract of *A. elongatum* has no inhibition activity against *E. faecalis* and *L. monocytogenes*, but it has inhibition activity against other indicator microorganisms. The other extracts of *A. elongatum* and all extracts of *C. macrospermum* were found to have inhibitory activity against all indicator microorganisms. Furthermore, the highest phenolic content was calculated as 54.60±0.486 µg mL^{-1} (*Ae*E) and the lowest content as 3.47±0.001 µg mL^{-1} (*Cm*A). As a result of the DPPH method the highest IC_{50} was calculated as 32.4140 µg mL^{-1} (*Cm*H) and the lowest IC_{50} as 12.7876 µg mL^{-1} (*Ae*A) and ABTS method the highest IC_{50} was calculated as 10.3203 µg mL^{-1} (*Cm*E), and the lowest IC_{50} as 0.2744 µg mL^{-1} (*Cm*A).
Conclusion: These results show that the plant extracts have strong antimicrobial activity and antioxidant activity.
Keywords: Antimicrobial, Antioxidant, Extraction, Medicinal Plants, Phenolic Component.

INTRODUCTION

Plants have ability to produce some phytochemicals against different environmental conditions or diseases. However, these chemicals are not always important to the plant, they have potential to used in different areas for people.[1,2] Nowadays, in the treatment of diseases, especially phytochemicals synthesized by medicinal and aromatic plants attract attention and studies in this field are increasing. In recent years, the number of microorganisms with multiple antibiotic resistance has increased considerably. Unfortunately, the effectiveness of existing antibiotics is decreasing day by day. In this context, phytochemicals that can be used against pathogens that are difficult to combat appear as natural products alternative to antibiotics. Furthermore phytochemicals have fewer side effects when compared to synthetic drugs.[3,4] It is seen that many different studies are carried out in different countries to show the usability of medicinal plants in the treatment of diseases.[5] It has been reported that phytochemicals of medicinal plant generally do not have side effects like synthetic drugs, and pathogens cannot quickly develop resistance against these phytochemicals.[4,6] Today, finding new antibacterial substances with different chemical composition and mechanisms of action are essential, as there is a shocking increase in new and re-emerging infectious diseases. For this reason, ethnopharmacologists work to identify bioactive molecule producing plants and to reveal the properties of these molecules, depending on modern research. New molecules are sought in plant biodiversity using ethnopharmacological data.[6] There are a growing number of reports regarding the assessment of antimicrobial effects of medicinal

plants. The emergence of resistant new pathogens and the ineffectiveness of chemotherapeutic agents against these pathogens reveals the need for potential antimicrobial molecule discovery, and medicinal plants become the most important element in new molecule discovery.[7] However, it is known that some medicinal plants contain antioxidant molecules that may have an important role in disease prevention by reducing oxidative stress.[8] It is known that free radicals play a very significant role in the development of tissue damage in very different human diseases. Until now, many medicinal plants have been claimed to exhibit beneficial health effects such as antioxidant and antimicrobial properties. However, the potential of many plants as sources for new drugs remains largely unexplored.[5]

The genus *Arum* and *Chaerophyllum* are among the plants frequently used for nutritional and therapeutic purposes in the different regions. Although the genus *Arum* (Araceae) is poisonous, it has been used for centuries for nutritional and medicinal purposes[9]. It is known that *Arum* species are used with traditional methods in removing the sores and swelling in the breasts of women, reducing the worms formed in the intestines, relieving the pains of postpartum women, treating headaches and treating some internal diseases.[10,11]

The *Arum* species have been widely explored by modern research for pharmaceutical discovery.[9] Furthermore, it is known that the genus *Chaerophyllum* (Apiaceae) is frequently used to relieve abdominal pain.[12] Traditionally, this plant has been used to reduce chest pains and relieve abdominal pain.[13] Studies were conducted with the genus *Arum* and *Chaerophyllum* in different regions and the results showed that these plants have the opportunity to be used in pharmacology.[9,14] Although, the species of these two plants have traditionally known medicinal and other uses in Hakkari (in Türkiye), their pharmacological properties have not yet been studied by scientific research. Based on the knowledge that plants have different characteristics in different ecological environments, some biological characteristics of these plants in Hakkari province were evaluated for the first time in this study.

In this study, antimicrobial activity assay, antioxidant activity assay and phenolic content assay of plant extracts were carried out in order to reveal some biological properties of *Arum elongatum* (Kari) and *Chaerophyllum macrospermum* (Mendi), which are frequently used for food and treatment purposes in Hakkari province.

MATERIALS AND METHODS

Plants, extraction and percentage yield analysis

The plants were obtained from markets in Hakkari (April-May 2016). The plants defined with the help of Prof. Dr. Fatih SATIL (Faculty of Arts and Science, Balıkesir University). The freshly supplied plants (stem and leaf parts) were dried at 40 °C and ground into powder. The samples were gradually extracted with hexane, ethanol and acetone for 24 hours. HPLC grade solvents were used. After each extraction, the substances were filtered and the liquid was taken to be evaporated. Evaporation was carried out at approximately 30 °C at 80-150 rpm. The percent yields of the extracts obtained after evaporation were calculated and were dissolved in Dimethyl Sulfoxide (DMSO, Merck) at rates of 20-100 µg ml^{-1}. Samples were stored at +4 °C.[15,16]

Microorganisms and culture conditions

In order to define the antimicrobial properties of plant extracts, the spectrum was kept wide and eukaryotic/prokaryotic pathogens were preferred as the causative agents of different diseases. In antimicrobial activity tests, *Salmonella* Typhimurium ATCC 14028, *Staphylococcus epidermidis* ATCC 12228, *Pseudomanas aeruginosa* ATCC 27853, *Klebsiella pneumoniae* ATCC 13883, *Yersinia pseudotuberculosis* ATCC 911, *Proteus vulgaris* ATCC 13315, *Enterococcus faecalis* ATCC 29212, *Bacillus subtilis* ATCC 6633, *Enterobacter cloaceae* ATCC 13047, *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 35218, *Listeria monocytogenes* ATCC 7644, and *Candida albicans* ATCC 90028 were used. Mueller Hinton Broth (MHB, Merck) or Mueller Hinton Agar (MHA, Merck) is used for the cultivation of microorganisms. Furthermore, microorganisms were cultured at 37°C for 16-18 h.[17,18]

Determination of antimicrobial activity

The inhibition activity of the plant extracts was determined with agar well diffusion assay.[19] Firstly, the indicator bacteria were incubated in MHB for 18-24 h. After incubation, bacterial dilutions were prepared at 10^8 cells/ml and 100 µl was spread on petri dishes containing MHA. Then, wells (6 mm diameter) were drilled on the petri dish and 100 µl of extracts were added to the wells and incubated at 37 °C for 16-18 h. At the end of the incubation period, it was detected by the zones around the wells. Antibiotic (ciprofloxacin 30µg/disc, Bioanalyse) was used as a positive control and DMSO was used as a negative control.[20,21]

Antioxidant activity by DPPH assay

Antioxidant activity of plant extracts were measured

by DPPH (1,1- diphenyl-2-picryl hydrazyl).[22,23] BHA was used as the standard compound. The mixture of DPPH and methanol was used as the control solvent. The antioxidant activity was evaluated as percent inhibition.[24]

Antioxidant activity by ABTS assay

ABTS radical scavenging activity assay was performed using ABTS (2,2-Azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)) free radical according to the method reported by Miller et al. (1993)[25] and developed by Re et al[26.] Methanol was used as the control solvent and Trolox (500-2500 µg mL^{-1}, Aldrich) was used as a standard compound.[27] Trolox is a water-soluble analog of vitamin E. Studies were repeated twice. The antioxidant activity was evaluated as percent inhibition.[24,27]

Evaluation of total phenolic component

The total phenolic content of the plants extracts was determined with the Folin-Ciocalteu reagent. The amounts of phenolic compounds corresponding to the gallic acid standard of the extracts were determined in the study.[28] Firstly, the stock solutions of the standard at a ratio of 1:1 (gallic acid:dH_2O) were prepared. Solutions were prepared at different concentrations (25-100 µg mL^{-1}) from the stock solution, and 100 µL of the solutions were taken and 4500 µL of dH_2O was added. Then, 100 µL of Folin-Ciocalteu reagent was added and after 3 minutes, 300 µL of 2% Na_2CO_3 solution was added and mixed. The samples were incubated in the dark for 2h. Then, absorbance was measured at 760 nm.

RESULTS

Percentage yield analysis of plant extracts and total phenolic component analysis

In this study, some biological properties of the genus *A. elongatum* and *C. macrospermum* were revealed. The % yields of the extracts obtained from the plants are given in Table 1. Highest extract yield *A. elongatum* ethanol extract (*Ae*E) 10.4011%, the lowest extract yield was *C. macrospermum* acetone extract (*Cm*A) calculated as 0.3510%. While the ethanol extract yield was the highest for both plants, the acetone extract yield was the lowest (Table 1).

The total phenolic content of the plant extracts was defined as gallic acid equivalent (µg mL^{-1}). When the plant extracts were compared, the total phenolic content of the extracts was found for *A. elongatum* as *Ae*E > *Ae*H > *Ae*A, for *C. macrospermum* as *Cm*E > *Cm*H > *Cm*A (Table 1). The maximum amount of phenolic compounds was determined in *A. elongatum* ethanol extract (54.60 ± 0.486 µg GAE mL^{-1}).

Antioxidant activity

DPPH radical scavenging activities of extracts of *A. elongatum* and *C. macrospermum* were evaluated as % inhibition and the results were compared with synthetic antioxidant BHA (Figure 1). Then the IC_{50} value of the extracts was calculated (Table 1).

ABTS radical scavenging activities of hexane, ethanol, and acetone extracts of *A. elongatum* and *C. macrospermum* were evaluated as % inhibition and the results were compared with the ABTS radical scavenging activity of synthetic antioxidant Trolox. According to the total graphic % inhibition data, the extracts showed ABTS radical scavenging activity close to Trolox (Figure 2). Then the IC_{50} value of the extracts was calculated (Table 1).

Table 1. The percent yield of extraction, antioxidant performance and total phenolic contents from *A. elongatum* and *C. macrospermum* plants.

Extracts	Yield of Extract (%)	Antioxidant activity (IC_{50})		Total Phenolic Content (µg GAE mL^{-1})
		DPPH	ABTS	
*Ae*H	2.20560	17.2355	3.84830	20.36 ± 0.199
*Ae*E	10.4011	31.5686	1.28930	54.60 ± 0.486
*Ae*A	0.84220	12.7876	2.87930	12.68 ± 0.092
*Cm*H	1.25650	32.4140	8.25350	09.44 ± 0.015
*Cm*E	2.48980	22.9518	10.3203	15.33 ± 0.004
*Cm*A	0.35100	15.6458	0.27440	03.47 ± 0.001
BHA	-	4.39670	-	-
Trolox	-	-	5.64650	-

*Ae*H; hexane extract of *A. elongatum*, *Ae*E; ethanol extract of *A. elongatum*, *Ae*A; acetone extract of *A. elongatum*, *Cm*H; hexane extract of *C. macrospermum*, *Cm*E; ethanol extract of *C. macrospermum*, *Cm*A; acetone extract of *C. macrospermum*. BHA and Trolox; standard compounds.

Volume: 4 **Issue: 1**
Year: 2023
DOI: 10.53811/ijtcmr.1233624

International Journal of Traditional and Complementary Medicine Research

Publisher
Duzce University

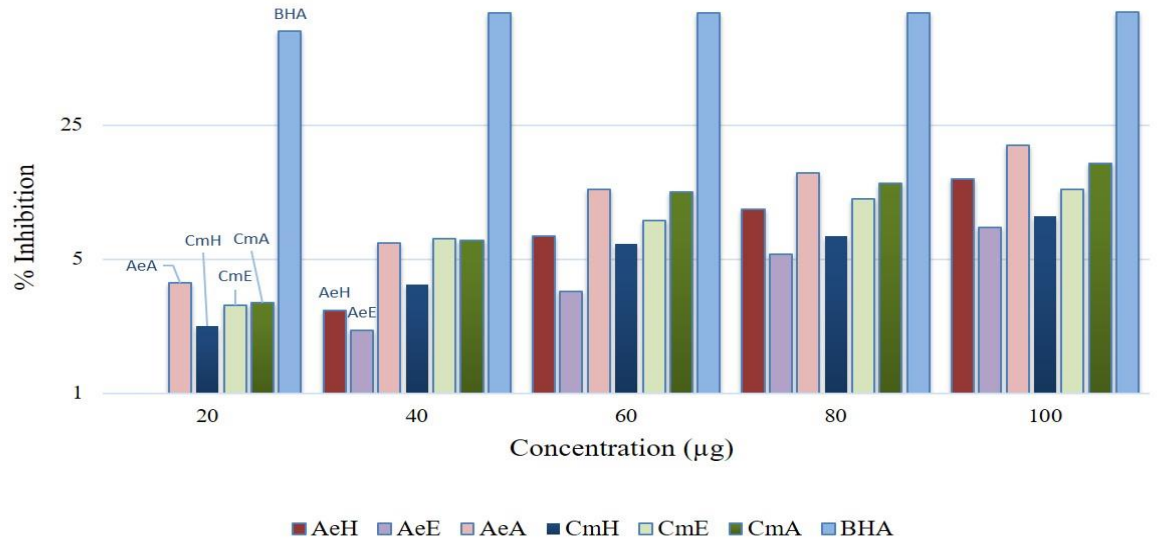

Figure 1. DPPH radical scavenging activity. AeH; hexane extract of *A. elongatum*, AeE; ethanol extract of *A. elongatum*, AeA; acetone extract of *A. elongatum*, CmH; hexane extract of *C. macrospermum*, CmE; ethanol extract of *C. macrospermum*, CmA; acetone extract of *C. macrospermum.*

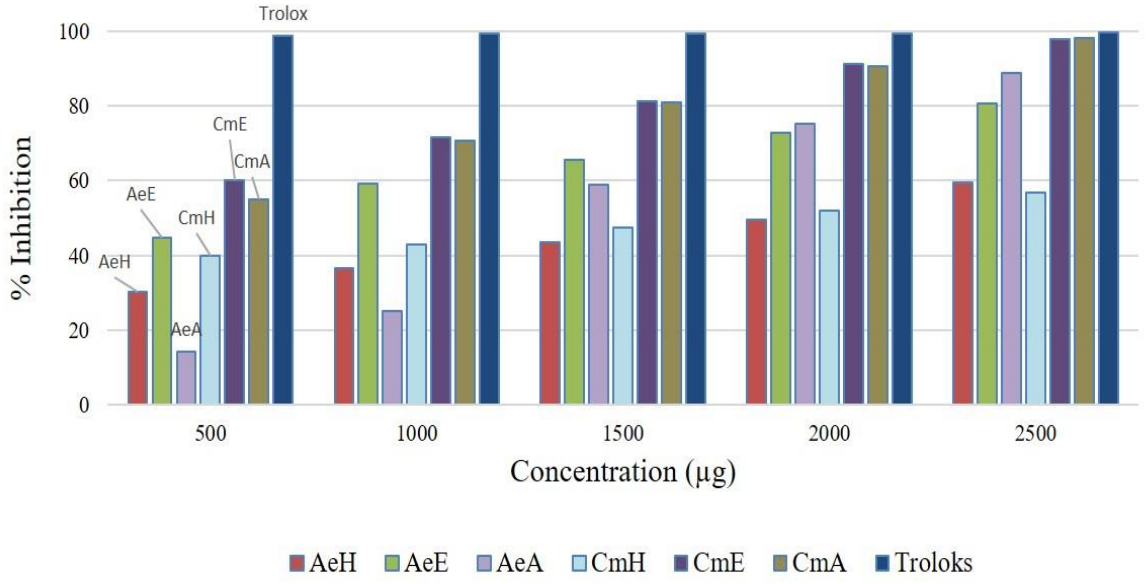

Figure 2. ABTS radical scavenging activity. AeH; hexane extract of *A. elongatum*, AeE; ethanol extract of *A. elongatum*, AeA; acetone extract of *A. elongatum*, CmH; hexane extract of *C. macrospermum*, CmE; ethanol extract of *C. macrospermum*, CmA; acetone extract of *C. macrospermum.*

Volume: 4 **Issue: 1**
Year: 2023
DOI: 10.53811/ijtcmr.1233624

International Journal of Traditional and Complementary Medicine Research

Publisher
Duzce University

Antimicrobial activity

When the hexane extract of *A. elongatum* are evaluated, it can be said that the hexane extract has high antimicrobial activity against microorganisms such as *E. cloaceae*, *S. typhimurium*, *S. epidermidis*, *P. vulgaris*, *Y. pseudotuberculosis*, *S. aureus*, *P. aeruginosa*, *K. pneumoniae*, *B. subtilis*, *E. coli* and *C. albicans* (Table 2). Furthermore, it was determined that ethanol and acetone extracts of *A. elongatum* showed inhibitory activity against all test microorganisms. It was determined that all three extracts of *C. macrospermum* had inhibitory activity against all indicator microorganisms (Table 2, Figure 3).

Table 2. Antimicrobial performance of the extracts from *A. elongatum* and *C. macrospermum.*

	Extracts / Inhibition zones (mm)							
Microorganisms	***Ae*H**	***Cm*H**	***Ae*E**	***Cm*E**	***Ae*A**	***Cm*A**	**CPFX**	**DMSO**
E. faecalis	-	07.5	12.5	21.0	17.5	18.0	29.0	-
***S.* Typhimurium**	24.0	21.5	13.0	20.0	21.0	23.0	36.0	-
K. pneumoniae	22.0	20.5	25.0	24.0	23.5	24.0	36.0	-
E. coli	06.5	18.5	06.5	16.5	06.5	16.5	35.0	-
P. vulgaris	15.5	15.0	15.0	14.0	15.5	14.0	36.0	-
L. monocytogenes	-	07.0	19.0	21.5	16.5	11.5	30.0	-
Y. pseudotuberculosis	17.0	18.5	17.0	19.0	18.5	18.0	26.0	-
P. aeruginosa	16.0	16.5	06.5	06.5	06.5	16.5	29.0	-
S. epidermidis	17.5	11.5	18.5	22.5	17.5	12.0	20.0	-
S. aureus	14.5	13.0	17.5	19.0	13.5	12.5	30.0	-
E. cloaceae	20.5	19.0	09.0	08.0	11.5	13.0	35.0	-
B. subtilis	14.5	14.0	14.5	13.5	15.0	17.0	38.0	-
C. albicans	24.5	26.0	19.0	20.5	19.0	20.0	-	-

CPFX; Ciprofloxacin, DMSO; Dimethyl Sulfoxide

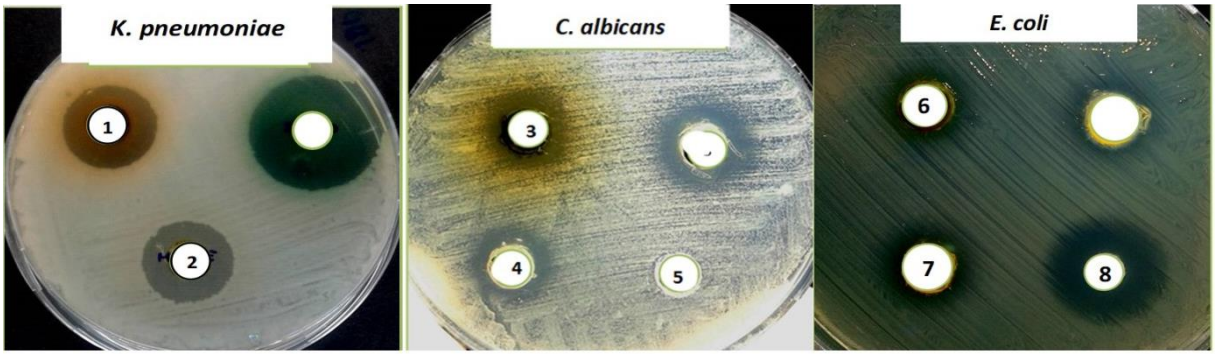

Figure 3. Antimicrobial activity analysis. 1;*Ae*E, 2;*Cm*E, 3;*Ae*A, 4;*Cm*A, 5;DMSO, 6;*Ae*H, 7;*Cm*H, 8; Streptomycin

DISCUSSION

Due to their increasing traditional uses and in daily life, the medicinal plants attract great attention and also gain global importance due to their low side effects. Herbal medicines, which in many cases are more cost-effective than synthetic medicines, are promoted by most of the developing countries. In this context, many studies are carried out on medicinal plants and their derivatives.[29] The plants of the genus *Arum* (Araceae) and *Chaerophyllum* (Apiaceae) have become a source of trade for the people of the different regions in Türkiye due to their intense use for food and especially for medicinal purposes. In this context, the plants of *A. elongatum* and *C. macrospermum* distributed in the Eastern Anatolia region, have also attracted the attention of some scientists, but there are few studies on these plants. However, there are no studies on the biological activities of *C. macrospermum* and *A. elongatum* distributed in Hakkari. In this study, some biological properties of the genus *A. elongatum* and *C. macrospermum* were revealed.

Results of the studies, the maximum extract yield was obtained in the ethanol extracts of the plants (*Ae*E;10.4011% *Cm*E;2.4898%), the minimum extract yield was obtained in the acetone extracts (*Ae*A;0.8422% *Cm*A;0.3510%). As a result of the DPPH method the highest IC_{50} was calculated as 32.4140 µg mL^{-1} (*Cm*H) and the lowest IC_{50} as 12.7876 µg mL^{-1} (*Ae*A) and ABTS method the highest IC_{50} was calculated as 10.3203 µg mL^{-1} (*Cm*E), and the lowest IC_{50} as 0.2744 µg mL^{-1} (*Cm*A). In a study conducted by Zengin Kurt et al.,[30] the biological abilities of *Arum maculatum* distributed in Ordu were evaluated. Similar to our study, hexane and ethanol extraction of the plant was performed in this study, and the antioxidant activities of the extracts were evaluated by ABTS method. When the results of this study are compared with the results of our study, it is seen that there is a very low extraction efficiency and a very low antioxidant capacity from our results. An extraction efficiency of 0.08% was obtained with hexane in this study, whereas an extraction efficiency of 2.21% was achieved with hexane in our study. In this study, 0.29% extraction efficiency was achieved with ethanol, and 10.40% extraction efficiency was achieved in our study. Accordingly, it is seen that the IC_{50} of our exracts values are considerably higher than in this study. Although *A. maculatum* and *A. elongatum* are members of the same genus, it is possible that both species differences and the environment in which they are distributed may have revealed these results.[30] In another study carried out by Alaca et al., some biological activities of 12 different types of edible plants, including *Arum conophalloides*, distributed in Hakkari and Van, were evaluated. It was observed that the results of the DPPH study were similar, especially due to the similar habitat with this study. However, considering the ABTS results, it can be said that they found a lower IC_{50} value than this results.[31] In another study conducted in 2022, the antioxidant activity of the essential oils of the *Chaerophyllum libanoticum* were determined. In this study, the IC_{50} values of different extracts of the genus *C. macrospermum* calculated as 0.27440-10.3203 mg mL^{-1}. In this study, the IC_{50} value of essential oil was calculated as 0.027 ± 0.008 mg mL^{-1}.[32] In this case, it can be said that the antioxidant activities of essential oils are higher than the antioxidant activities of plant extracts. Essential oils contain components with phenolic hydroxyl groups and therefore show strong antioxidative properties.

As a result of total phenolic analysis, the highest phenolic content was calculated as 54.60±0.486 µg mL^{-1} (*Ae*E) and the lowest content as 3.47±0.001 µg mL^{-1} (*Cm*A). In another study published in 2021, it is observed that the antioxidant properties of the *Arum italicum* plant grown in Trabzon were evaluated. In this study, the total phenolic contents of different extracts of the *A. elongatum* were determined as 12.68±0.092 - 54.60 ± 0.486 µg GAE mL^{-1}. In 2021, the total phenolic content of the inedible parts of the *A. italicum* plant was determined as 164 µg GAE mL^{-1}. It can be said that the phenolic contents of inedible plant parts were found higher than the phenolic contents of the edible parts in this study.[33]

The hexane extract of *A. elongatum* has no inhibition activity against *E. faecalis* and *L. monocytogenes*, but it has inhibition activity against other indicator microorganisms such as *S.* Typhimurium, *S. epidermidis*, *P. aeruginosa*, *K. pneumoniae*, *Y. pseudotuberculosis*, *P. vulgaris*, *B. subtilis*, *E. cloaceae*, *S. aureus*, *E. coli*, and *C. albicans*. The other extracts of *A. elongatum* and all extracts of *C. macrospermum* were found have inhibitory activity against all indicator microorganisms such as *S.* Typhimurium, *S. epidermidis*, *P. aeruginosa*, *K. pneumoniae*, *Y. pseudotuberculosis*, *P. vulgaris*, *B. subtilis*, *E. cloaceae*, *S. aureus*, *E. coli*, *E. Faecalis*, *L. monocytogenes*, and *C. albicans*. When the hexane extract of *A. elongatum* is evaluated, it can be said that the hexane extract has high antimicrobial activity against microorganisms such as *E. cloaceae*, *S. typhimurium*, *S. epidermidis*, *P. vulgaris*, *Y.*

pseudotuberculosis, *S. aureus*, *P. aeruginosa*, *K. pneumoniae*, *B. subtilis*, *E. coli* and *C. albicans*. Furthermore, it was determined that ethanol and acetone extracts of *A. elongatum* showed inhibitory activity against all test microorganisms. It was determined that all three extracts of *C. macrospermum* had inhibitory activity against all indicator microorganisms. In a study conducted in 2018, ethanol and water extracts of *Arum elongatum* plant collected from the Muş Province in Türkiye were obtained. As a result of the study, it was determined that the ethanol extract has low antimicrobial activity against microorganisms such as *B. subtilis* and *S. aureus, E. aerogenes, E. coli, P. aeroginosa K. pneumonia, S. cereviciae*. It is seen that the antimicrobial activity results are considerably lower than the antimicrobial activity results obtained in this study. In addition, in 2018, it was seen that the *A. elongatum* plant had a good antioxidant activity capacity as in our study.[11] The other study conducted in 2009, leaf extracts of the *Arum maculatum* plant distributed in Kahramanmaras (Türkiye) were obtained and it was determined that the extracts have high inhibition activity against different microorganisms such as *Bacillus cereus, Micrococcus luteus, Pseudomonas phaseolicola, Yersinia enterocolitica, Enterobacter aerogenes* and *Aspergillus niger*.[34] In this study, the extracts of the *Arum elongatum* were found *E. faecalis, S. typhimurium, K. pneumoniae, E. coli, P. vulgaris, L. monocytogenes, Y. pseudotuberculosis, P. aeruginosa, S. epidermidis, S. aureus, E. cloaceae, B. subtilis* and *C. albicans* have been found to have high inhibitory activity. When these results are evaluated, it shows that the extracts of the genus *Arum* have broad-spectrum antimicrobial activity. In another study, antimicrobial and antioxidant activity studies of the extracts obtained from the *Arum hygrophilum* plant collected from the Jordan region were carried out. The extracts were found to have high antimicrobial activity against *S. aureus* ATCC29213, *Listeria monocytogenes* ATCC7644 and methicillin-resistant *Staphylococcus aureus* (MRSA).[35] It is promising that the extracts have high activity especially against MRSA. In this study, there were no resistant pathogens as an indicator for the determination of the efficacy of the extracts, but it will be important to study the effectiveness of such resistant pathogens in future studies.

In a study conducted in 2021, it is observed that only the essential oil compositions of the aerial parts of *Chaerophyllum macrospermum* collected from Bitlis and Hakkari in Türkiye are detected.[14] In a 2018 study, the antioxidant and antimicrobial activity properties of methanol, ethanol, and acetone extracts of some plants, including the genus *Chaerophyllum*, were investigated. Antioxidant activities of the extracts were determined by DPPH and ABTS radical methods and antimicrobial activities were determined by agar well diffusion method. As a result of this study, it was seen that the extracts of plants can be used as natural antimicrobials and antioxidants in food processing.[36] The results of this study support our study. In another study, local cheese (Van herbed cheese) containing more than 60 plant species belonging to 9 different families, including the genus *Chaerophyllum*, were examined. As a result of this study, it was determined that the local cheese was enriched in vitamin C, crude fiber, macro and micronutrients due to the plants used, and also these plants gave the cheese antimicrobial and antioxidant properties due to the bioactive substances they contain.[37] In a study conducted in 2005, the inhibitory activity of *Chaerophyllum crinitum*, one of the plants added to herbed cheese, against some pathogenic bacteria was investigated and this plant has been described as having inhibitory activity against *K. pneumoniae, P. aeruginosa* and *S. aureus.*[19] In a study by Hayta et al., the antioxidant and antimicrobial activities of the extracts obtained from the *Chaerophyllum crinitum* plant grown around Bitlis (in Türkiye) were tested. When the result of the study was evaluated, it was observed that the DPPH activity could not be defined. While it was determined that the extracts of the genus *Chaerophyllum* had inhibitory activity against *E. faecalis and S. aureus*, it did not have inhibitory activity against *E. coli.*[38] However, when these results are compared with the results of antimicrobial activity studies performed in this study, it is seen that our *C. macrospermum* extracts have much higher antimicrobial activity against all bacteria, including *E. coli*. In 2016, the antioxidant and antimicrobial activities of the plant extract of *Chaerophyllum aureum* were determined.[39] When the results are examined, it is seen that the extracts have a very high antioxidant capacity, as in this study.[39] However, inhibition activity could not be detected against *Bacillus subtilis* ATCC 6633, *Staphylococcus aureus* ATCC6538, *Escherichia coli* ATCC 8739, *Pseudomonas aeruginosa* ATCC9027, *Salmonella abony* ATCC6017.[39] On the other hand, the extracts of *Chaerophyllum macrospermum* obtained in this study seem to have high antimicrobial activity.

CONCLUSION

In this context, bioactive molecule extraction of the

A. elongatum and *C. macrospermum* grown in Hakkari for the first time, and then antimicrobial, antioxidant and total phenolic component analyzes of these extracts were performed in this study. As a result of this study, which was planned to reveal the scientific importance of these plants, which is frequently used and very valuable in Hakkari and the surrounding provinces, it was determined that the *A. elongatum* and *C. macrospermum* each showed good antioxidant and antimicrobial properties. However, to use these plants in pharmacological studies, some biological properties of which were investigated in the study, more detailed studies are required.

Disclosure Statement: The authors have no conflicts of interest to declare.

Author contributions: Conceptualization: [SU]; Design: [SU]; Writing: [SU, SUL]; Investigation/ Data collection: [SU, SUL]

Conflict of Interest: There is no potential conflict of interest relevant to this article.

Funding: No financial support.

REFERENCES

1. Mahmood MH, Osama AK, Makky EA, Rahim MH, Ali NHM, Hazrudin ND. Phytochemical screening, antimicrobial and antioxidant efficacy of some plant extracts and their mixtures. *IOP Conf. Ser. Earth Environ. Sci.* 2019;346:012003.
2. Chrysargyris A, Mikallou M, Petropoulos S, Tzortzakis N. Profiling of essential oils components and polyphenols for their antioxidant activity of medicinal and aromatic plants grown in different environmental conditions. *Agron.* 2020; 10(5):727.
3. Veeresham C. Natural products derived from plants as a source of drugs. *J. Adv. Pharm. Technol. Res.* 2012; 3: 200-201.
4. Nisar B, Sultan A, Rbab SL. Comparison of medicinally important natural products versus synthetic drugs. *Nat. Prod. Chem. Res.* 2017;6(2):308.
5. Subba B, Basnet P. Antimicrobial and antioxidant activity of some indigenous plants of Nepal. *J Pharmacogn. Phytochem.* 2014;3(1):62-67.
6. Anand U, Jacobo-Herrera N, Altemimi A, Lakhssassi N. A comprehensive review on medicinal plants as antimicrobial therapeutics: potential avenues of biocompatible drug discovery. *Metabolites.* 2019;9(11):258.
7. Belhaj S, Dahmani J, Belahbib N, Zidane L. Ethnopharmacological and ethnobotanical study of medicinal plants in the High Atlas Central, Morocco. *Ethnobot. Res. Appl.* 2020;20:18.
8. Sarwar R, Farooq U, Khan A, Naz S, Khan S, Khan A, Rauf A, Bahadar H, Uddin R. Evaluation of antioxidant, free radical scavenging, and antimicrobial activity of *Quercus incana* Roxb. *Front. Pharmacol.* 2015; 6: 277.
9. Azab A. Arum: A plant genus with great medicinal potential. *Eur. Chem. Bull.* 2017;6(2):59-68.
10. Ağalar HG. *Arum italicum* Miller üzerinde farmakognozik araştırmalar. Anadolu Üniversitesi Sağlık Bilimleri Enstitüsü Farmakognozi Anabilim Dalı. Eskişehir, 2016.
11. Alan Y. *Arum elongatum* Steven ekstraktlarının fenolik madde miktarı ve biyolojik aktivitelerinin incelenmesi. *Bitlis Eren Univ. J. Sci. and Technol.* 2018;7(2):370-379.
12. Kardaş C. Muş'ta yabani bitkilerin halk hekimliğinde kullanılması. Lokman Hekim Derg. 2019; 9(1):85-96.
13. Uce İ, Tunçtürk M. Hakkâri' de doğal olarak yetişen ve yaygın olarak kullanılan bazı yabani bitkiler. *Biyoloji Bilimleri Araştırma Derg.* 2014;7(2):21-25.
14. Ağalar HG, Altıntaş A, Demirci B. The essential oil profiles of *Chaerophyllum crinitum* and *C. macrospermum* growing wild in Turkey. *Nat. Volatiles and Essent Oils.* 2021;8(1):39-48.
15. Baravalia Y, Kaneria M, Vaghasiya Y, Parekh J, Chanda S. Antioxidant and antibacterial activity of *Diospyrosebenum* roxb. leaf extracts. *Turk. J. Biol.* 2009;33:159.
16. Anokwuru CP, Anyasor GN, Ajibaye O, Fakoya O, Okebugwu P. Effect of extraction solvents on phenolic, flavonoid and antioxidant activities of three Nigerian medicinal plants. *Nat. Sci. Sleep.* 2011;9(9):7.
17. Rimek D, Fehse B, Göpel P. Evaluation of Mueller-Hinton-agar as a simple medium for the germ tube production of *Candida albicans* and *Candida dubliniensis. Mycoses.* 2008;51(3):205-208.
18. Sen A, Batra A. Evaluation of antimicrobial activity of different solvent extracts of medicinal plant: *Melia azedarach* L. *Int. J. Curr. Pharm. Res.* 2012;2:4.
19. Chung KT, Thomasson WR, Wu-Yuan CD. Growth inhibition of selected food-borne bacteria, particularly *Listeria monocytogenes*, by plant extracts. *J. Appl. Bacteriol.* 1990;69(4):498-503.
20. Bahar Bilgin S, Ugras S, Sarı HY, Ugras HI, Yanardag R. Antibacterial, antiurease and antioxidant activities of some arylidene barbiturates. *Appl. Biochem. Biotechnol.* 2013;171(8):2030-2039.
21. Arullappan S, Zakaria Z, Basri D F. Preliminary screening of antibacterial activity using crude extracts of Hibiscus Rosa sinensis. *Trop. Life Sci. Res.* 2009;20(2):109-118.
22. Brand-Williams W, Cuvelier M E, Berset C. Use of a free radical method to evaluate antioxidant activity. *Lebensm. Wiss. Technol.* 1995;28(1):25-30.
23. Ertürk O, Şahin H, Kolaylı S, Çol Ayvaz M. Antioxidant and antimicrobial activity of East Black Sea Region honeys. *Turk. J. Biochem.* 2014;39:99-106.
24. Ugras S, Ülger S, Göç Rasgele P. Evaluation of biological activity of *Diplotaenia cachrydifolia* Boiss. that medicinal plant.

Istanbul J. Pharm. 2019;49 (2):45-52.
25. Miller NJ, Rice-Evans C, Davies MJ, Gopinathan V, Milner A. A novel method for measuring antioxidant capacity and its application to monitoring the antioxidant status in premature neonates. *Clin. Sci.* 1993;84(4):407-412.
26. Re R, Pellegrini N, Proteggente A, Pannala A, Yang M, Rice-Evans C. Antioxidant activity applying an improved ABTS radical cation decolorization assay. *Free Radic. Biol. Med.* 1999;26(9-10):1231-1237.
27. Kahraman S. Labada (*Rumexcristatus* DC)'nın antioksidan aktivitesi. İstanbul Üniversitesi Fen Bilimleri Enstitüsü. İstanbul, 2009.
28. Döğer MM. Ispit'in (*Trachystem onorientalis* (L.) G. Don) antioksidan aktivitesi. İstanbul Üniversitesi Fen Bilimleri Enstitüsü. İstanbul, 2010.
29. Walia Z, Sachchida N R, Hareram B, Saumitra S S. Economic importance of medicinal plants in Asian countries. *Energy Sustain Dev.* 2020;359-377.
30. Zengin Kurt B, Gazioğlu I, Sevgi E, Sönmez F. Anticholinesterase, antioxidant, antiaflatoxigenic activities of ten edible wild plants from Ordu Area, Turkey. *IJPR.* 2018;17(3):1047-1056.
31. Alaca K, Okumuş E, Bakkalbaşı E, Javıdıpour I. Phytochemicals and antioxidant activities of twelve edible wild plants from Eastern Anatolia, Turkey. *Food Sci. Technol.* 2022;42:e18021.
32. Kürkçüoğlu M, Ağalar HG, Temiz B, Duran A, Başer KHC. *Chaerophyllum libanoticum* Boiss. Et Kotschy: The fruit essential oil, composition, skin-whitening and antioxidant activities. *Eur. J. Biol.* 2022;1:28-34.
33. Akar Z, Demir Ç, Alkan O, Can Z, Akar B. LC–MS/MS and RP–HPLC–UV Analysis and Antioxidant Activities of *Arum italicum* miller edible and nonedible tuber parts. J. *Anatolian Env. and Anim. Sci.* 2021;6(3):294-301.
34. Çolak F, Savaroğlu F, İlhan S. Antibacterial and antifungal activities of Arum maculatum L. leaves extracts. J. *Appl. Biol. Sci.* 2009;3(3):13-16.
35. Al-Daghistani HI, Abu-Niaaj LF, Bustanji Y, Al-Hamaideh KD, Al-Salamat H, Nassar MN, Jaber HM, Amer NH, Abu-Irmaıleh B, Al-Nuaimi AHD. Antibacterial and cytotoxicity evaluation of *Arum hygrophilum* Bioss. *Eur. Rev. Med. Pharmacol. Sci.* 2021;25:7306-7316.
36. Köse Ş, Ocak E. Antimicrobial and antioxidant properties of Sirmo (*Allium vineale* L.), Mendi (*Chaerophyllum macropodum* Boiss.) and Siyabo (*Ferula rigidula* DC.). *Gıda.* 2018;43(2):294-302.
37. Tunçtürk M, Tunçtürk R. Van otlu peyniri ve yapımında kullanılan bitkiler ile ilgili genel bir değerlendirme. *Ziraat Fakültesi Derg.* 2020;238-244.
38. Hayta Ş, Çelikezen FÇ. Evaluation of essential oil composition, antioxidant and antimicrobial properties of *Chaerophyllum crinitum* Boiss (Apiaceae) from Turkey: A Traditional Medicinal Herb. *J. Biol. Sci.* 2016;1-5.
39. Stamenković JG, Petrović G, Stojanović G, Đorđević AS., Zlatković. B. *Chaerophyllum aureum* L. volatiles: composition, antioxidant and antimicrobial activity. *Rec. Nat. Prod.* 2016;10(2):245-250.