PROSPECTS
IN PHARMACEUTICAL SCIENCES

Prospects in Pharmaceutical Sciences, 22(3), 164-169
https://prospects.wum.edu.pl/

Original Article

MISTLETOE (*LORANTHUS EUROPAEUS* JACQ.): ANTIOXIDANT, ANTIMICROBIAL AND ANTICHOLINESTERASE ACTIVITIES

Nazan Çömlekçioğlu[1], Nuh Korkmaz[2], Mehmet Ali Yüzbaşıoğlu[3], İmran Uysal[4], Mustafa Sevindik[2*],

[1] *Department of Biology, Faculty of Science, Kahramanmaras Sutcu Imam University, 46050 Kahramanmaras, Turkiye.*

[2] *Department of Biology, Faculty of Engineering and Natural Sciences, Osmaniye Korkut Ata University, 80000 Osmaniye, Türkiye.*

[3] *Oguzeli Vocational School, University of Gaziantep, 27900, Gaziantep, Türkiye*

[4] *Department of Food Processing, Bahçe Vocational School, Osmaniye Korkut Ata University, 80000 Osmaniye, Türkiye.*

* Correspondence, e-mail: sevindik27@gmail.com

Received: 21.04.2024 / Accepted: 07.08.2024 / Published: 23.09.2024

ABSTRACT

Plants are natural resources responsible for different biological activities. Determining the biological activities of plants is very important. In our study, some biological activities and total phenolic and flavonoid contents of *Loranthus europaeus* Jacq. were determined. In this context, ethanol and methanol extracts of the plant were obtained using the soxhlet device. Total antioxidant, total oxidant, and oxidative stress statuses were determined using Rel Assay kits. Antimicrobial activity was tested against standard bacterial and fungal strains using the agar dilution test. Anticholinesterase activity was determined by detecting acetylcholinesterase (AChE) and butyrylcholinesterase (BChE) activities. Determination of total phenolic content was determined using the Folin-Ciocalteu reagent. Total flavonoid quantification was performed using an aluminum chloride assay. As a result of the study, TAS values (Total antioxidant status) of ethanol and methanol extracts of the plant were determined as 5.620±0.134 and 6.384±0.134 mmol/L, respectively. TOS values (Total oxidant status) were determined as 10.997±0.183 and 13.368±0.222 µmol/L, respectively. OSI values (Oxidative stress index) were measured as 0.196±0.004 and 0.209±0.003, respectively. TPC (Total phenolic content) value was determined as 34.49±1.78 and 55.82±2.34 mg/g, respectively, and TFC (Total flavonoid content) value was determined as 46.10±2.40 and 55.49±1.15 mg/g, respectively. Ethanol and methanol extracts of the plant were found to be effective against bacterial and fungal strains at concentrations between 50-200 µg/mL. In addition, the anti-AChE values of ethanol and methanol extracts were determined as 13.51±0.81 and 22.79±1.86 µg/mL, respectively, and the anti-BChE values were determined as 27.84±0.62 and 33.08±1.63 µg/mL, respectively. According to the results obtained, it was determined that *L. europaeus* has antioxidant, antimicrobial, and anticholinesterase activity. In this context, it is thought that it can be used as a natural material in pharmacological designs.

KEYWORDS: Antioxidant, medicinal plants, mistletoe, natural products.

1. Introduction

Today, many natural products are used within the scope of complementary or alternative medicine. Before the development of modern medicine, people turned to natural products to combat different diseases [1]. In this context, natural products such as mushrooms, plants, and animals have become a solution for people to fight against diseases. Among natural products, plants are the most important materials with a history equivalent to human history [2]. Plants have been used in many communities for many purposes such as animal and human nutrition, shelter, heating, making equipment, tools, and fighting diseases. Plants that stand out with their nutritional properties are widely used, especially in the fight against diseases [3]. In studies conducted by different researchers, it has been reported that plants have different biological activities such as anticancer, antimicrobial, antioxidant, anti-inflammatory, antiproliferative, antiaging, hepatoprotective, and DNA

protective [2,4-9]. In this context, determining the biological activities of plants is very important in terms of their usage potential [10]. *Loranthus europaeus* was used as material in this study. The plant's antioxidant, antimicrobial, anticholinesterase activities, and total phenolic and flavonoid contents were determined.

Loranthus is a genus of parasitic plants that grows on the branches of woody trees. In different beliefs, mistletoe is considered a cure for infertility in animals, an antidote against poison, and is considered sacred when it grows on oak trees [11]. It is known as *Loranthus europaeus* (Loranthaceae) in Europe: European yellow mistelotoe, Summer mistletoe, in Italy: Vischio quercino, in Arabic: Hib el-debgh [12-14]. It is distributed in Central and Southeastern Europe and the Eastern Mediterranean region, as well as in some parts of Asia Minor [15]. *L. europaeus* is a deciduous plant with dull brown whorls. It blooms in May and June. The fruits are yellow and round in shape. Additionally, its fruits ripen towards the end of autumn [16].

2. Materials and Methods

Loranthus europaeus specimens were collected from Hatay/Turkey on *Quercus* sp. The species identification of the plant was made using Flora of Turkey and the East Aegean Islands. Vol. 7 [17]. Plant herbarium samples are kept in Osmaniye Korkut Ata University, Biology Laboratory. All parts of the plant were used for analyses. Plant samples were dried in a laboratory environment away from direct sunlight. The dry samples were then ground into powder. 30 g of the samples were weighed and filled into soxhlet cartridges. It was then subjected to extraction with 250 mL of ethanol at 50 °C for approximately 6 hours. The process was repeated to obtain methanol extracts.

2.1. Total Antioxidant and Oxidant parameters

Total antioxidant and oxidant levels of the samples were determined using Rel Assay kits. Total antioxidant values were determined using TAS (Total antioxidant status) kits and expressed as mmol Trolox equivalent/L. Total oxidant values were measured with TOS (Total oxidant status) kits and expressed as µmol hydrogen peroxide equivalent/L. The tests were carried out following the manufacturer's protocol [18,19]. The OSI value (Oxidative stress index), which shows the percentage of oxidant compounds suppressed by antioxidant compounds, was measured by equalizing the units of the TOS value and the TAS value and taking the percentage by proportioning them [20].

2.2. Antimicrobial activity tests

The antimicrobial activities of ethanol and methanol extracts of the plant were tested against standard bacterial and fungal strains. Stock solutions were prepared at concentrations between 12.5-800 µg/mL by dilution method. Bacterial strains were precultured in Muller Hinton Broth medium. Fungal strains were pre-cultured in RPMI 1640 Broth medium. The findings were expressed in µg/mL [21-24].

Bacterial strains used: *Staphylococcus aureus* ATCC 29213, *S. aureus* MRSA ATCC 43300, *Enterococcus faecalis* ATCC 29212, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853 and *Acinetobacter baumannii* ATCC 19606.

Fungal strains used were: *Candida albicans* ATCC 10231, *C. krusei* ATCC 34135 and *C. glabrata* ATCC 90030.

2.3. Anticholinesterase activity test

Anticholinesterase activity of the extracts was determined using the Ellman method [25]. Extracts were diluted to concentrations ranging from 3.125-200 µg/mL. 130 µL of 0.1 M pH=8 phosphate buffer, 10 µL of stock solution, and 20 µL of enzyme (acetylcholinesterase (AChE) or butyrylcholinesterase (BChE) enzyme solution) were added to the microplate. The resulting mixture was incubated at 25 °C in the dark for 10 min, and then 20 µL of DTNB (5,5"-dithiobis-(2-nitrobenzoic acid)) solution and 20 µL of a substrate (acetylcholine iodide or butyrylcholine iodide) were added to the solution. Then, the reading was done at 412 nm. IC50 values (half-maximal inhibitory concentration) of the results were calculated and expressed as µg/mL.

2.4. Total Phenolic and Total Flavonoid Analysis

1 mL stock solutions were prepared from the extracts and 1 mL of Folin-Ciocalteu reagent (1:9, v/v) was added and mixed. Then, 0.75 mL of 1% Na_2CO_3 was added to this solution. Then, it was incubated at room temperature for 2 hours and the reading was taken at 760 nm. According to the calibration curve of the gallic acid standard solution, the total phenolic content was expressed in mg/g [26].

Total flavonoid levels of the extracts were measured by aluminum chloride test [27]. For the test, 0.1 mL 10% $Al(NO_3)_3$, 0.1 mL 1 M NH_4CH_3COO, 4.3 mL methanol, 0.5 mL Quercetin and 0.5 mL plant extract were mixed. The mixture was then incubated for 40 minutes. Then, absorbance was measured at 415 nm. Total flavonoid content was expressed in mg/g.

3. Results and Discussion

3.1. Total phenolic and total flavonoid contents

Plants produce secondary metabolites as a result of their defense systems. These compounds do not have nutritional properties but are medically important compounds [28,29]. In our study, the total phenolic and flavonoid contents of the ethanol and methanol extracts of *L. europaeus* are shown in Table 1.

Table 1. TAS, TOS, OSI, TPC and TFC values of *Loranthus europaeus*

Parameters	Solvents	
	Ethanol	Methanol
TAS (mmol/L)	5.620±0.134	6.384±0.134
TOS (µmol/L)	10.997±0.183	13.368±0.222
OSI (TOS/(TASx10))	0.196±0.004	0.209±0.003
TPC (mg/g)	34.49±1.78	46.10±2.40
TFC (mg/g)	55.82±2.34	55.49±1.15

As a result of the study, the TPC value (Total phenolic content) of the methanol extract of the plant was found to be higher than the ethanol extract. In addition, the TFC value (Total flavonoid content) of the ethanol extract of the plant was found to be higher than the methanol extract. In the literature, in a study conducted in Tunisia, it was reported that the total phenol value of the methanol extract obtained from *L. europaeus* was

between 72.59-83.98 mg GAEs/g and the total flavonoid value was between 63.61-139.73 mg QEs/g [30]. In a study conducted in Iraq, it was reported that the flavonoid value of the methanol extract obtained from the fruit of *L. europaeus* was 2.545 mg/g [31]. In a study conducted in Greece, it was reported that the total phenol value of the methanol extract obtained from the aerial part of *L. europaeus* was 94-320 mg/g and the total phenol value of the methanol extract obtained from the root part was 197 mg/g. It has also been reported that the total phenol value of the ethyl acetate extract obtained from the aerial part is 61-313 mg/g and the total phenol value of the ethyl acetate extract obtained from the root part is 246 mg/g [32]. In our study, it was observed that the total phenolic and flavonoid contents of the ethanol extract of *L. europaeus* were 34.49 mg/g and 55.82 mg/g, while the methanol extract was 46.10 mg/g and 55.49 mg/g. When we compared it with literature studies, it was seen that the results we found were within normal values. As a result, it is thought that *L. europaeus* plant may be an important source of phenolic and flavonoid content.

3.2. Antioxidant activity

Oxidant compounds are free radicals routinely produced as a result of metabolic activities [33]. While low levels of these compounds can be tolerated by the body, they can have harmful effects as levels increase [34]. The antioxidant defense system suppresses or eliminates the effects of oxidant compounds [35]. However, in some cases, the balance between antioxidant and oxidant compounds is disrupted. In this case, oxidative stress occurs. As a result of oxidative stress, serious diseases such as cardiological disorders, Parkinson's disease, Alzheimer's disease, multiple sclerosis and cancer may occur in humans [36,37]. Supplemental antioxidants can be used to reduce the negative effects of oxidative stress. In this context, plants are the natural products with the highest antioxidant potential. In our study, the antioxidant potential of *L. europaeus* was determined. In this context, TAS, TOS and OSI values of the ethanol and methanol extracts of the plant were determined and shown in Table 1. In literature reviews, it has been reported that *L. europaeus* has antioxidant activity using different methods [30,32,38]. In literature research, no study was found on the TAS, TOS and OSI values of *L. europaeus*. With our study, TAS, TOS and OSI values of *L. europaeus* were determined for the first time. It was measured that the TAS, TOS and OSI values of the methanol extract of *L. europaeus* used in our study were high when compared to the results found in the ethanol extract. In TAS, TOS and OSI studies conducted on different plant species, TAS values of *Helianthemum salicifolium, Silybum marianum, Rumex scutatus, Asparagus officinalis, Galium aparine* and *Salvia absconditiflora* were reported as 9.490, 5.767, 8.656, 6.238, 5.147 and 7.350 mmol/L, respectively. TOS values were reported as 14.839, 12.144, 4.951, 13.892, 18.679 and 8.501 µmol/L, respectively. OSI values have been reported as 0.157, 0.211, 0.057, 0.221, 0.346 and 0.116, respectively [39-44]. The TAS value of the ethanol extract of *L. europaeus* used in our study was determined to be higher than that of *G. aparine* and lower than that of *H. salicifolium, S. marianum, R. scutatus, A. officinalis* and *S. absconditiflora*. The TAS value of the methanol extract of *L. europaeus* was determined to be lower than that of *H. salicifolium, R. scutatus* and *S. absconditiflora*, and higher than that of *S. marianum, A. officinalis* and *G. aparine*. TAS value shows the totality of antioxidant compounds produced within the plant [45]. When the TAS values of *L. europaeus* used in our study were examined, it was seen that it had antioxidant potential. TOS values are an indicator of the totality of oxidant-active compounds produced within natural products [45]. The TOS value of the ethanol extract of *L. europaeus* used in our study was determined to be lower than that of *H. salicifolium, S. marianum, A. officinalis* and *G. aparine*, and higher than that of *R. scutatus* and *S. absconditiflora*. The TOS value of the methanol extract of *L. europaeus* was determined to be lower than that of *H. salicifolium, A. officinalis, G. aparine*, and higher than that of *S. marianum, R. scutatus* and *S. absconditiflora*. In this context, it can be seen that the TOS values of *L. europaeus* are generally high. OSI value is used to express the percentage of oxidant compounds suppressed by antioxidant compounds [45]. To use natural products, the OSI value must be low. The OSI value of both ethanol and methanol extracts of *L.* europaeus used in our study was determined to be higher than *H. salicifolium, R. scutatus*, and *S. absconditiflora*, and lower than *S. marianum, A. officinalis* and *G. aparine*. In this context, it has been observed that the ability of *L. europaeus* to suppress oxidant compounds is at normal levels. As a result, it was determined that *L. europaeus* has antioxidant potential.

3.3. Antimicrobial activity

Nowadays, the number of microbial diseases is increasing. The number of resistant microorganisms due to pollution of nature and unconscious use of antibiotics triggers the increase in the number of these diseases [46]. The antimicrobial drugs used are insufficient. In this context, researchers have turned to the discovery of new antimicrobial drugs [47,48]. Plants occupy an important place among natural antimicrobial sources. In our study, the effect of *L. europaeus* against standard bacterial and fungal strains was investigated. The findings obtained are shown in Table 2.

Table 2. Antimicrobial potential of *Loranthus europaeus*

Microorganisms	Solvents (µg/mL)	
	Ethanol	Methanol
S. aureus	200	200
S. aureus MRSA	100	200
E. faecalis	100	100
E. coli	100	200
P. aeruginosa	100	200
A. baumannii	50	100
C. glabrata	50	200
C. albicans	100	200
C. krusei	100	200

50, 100, 200 µg/mL - the lowest extract concentrations that prevent the growth of microorganisms

Considering the research in the literature, a study conducted in Iran investigated the antimicrobial status of the essential oil and hydroalcoholic extract of *L. europaeus* against *Acinetobacter baumannii*, *Staphylococcus aureus*

and *Pseudomonas aeruginosa*. In the study, minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) values were examined. Among the strains used, it was reported that the best MIC value was 6 µg/mL in *S. aureus* and the best MBC value was 196 µg/mL in *S. aureus* [49]. In a study conducted in Italy, the antimicrobial effect of the protein extract obtained from the sample of *L. europaeus* on *Aspergillus niger*, *Alternaria* spp., *Penicillium* spp., *Botritis cinereus*, *Listeria monocytogenes*, *S. aureus*, *Salmonella typhimurium* and *Escherichia coli* strains was investigated. As a result of the study, it was reported that the best MIC value among bacterial strains was 0.50 mg/mL in *S. typhimurium* and the best MBC value was 0.38 mg/mL in *L. monocytogenes*. Additionally, among fungal strains, it has been reported that the colony diameter result is 2.0-3.5 cm with the best effect in the sporulation of *A. niger* [50]. In a study conducted in Iraq, the antimicrobial effect of the aqueous and alcohol extract of *L. europaeus* on *S. aureus* was examined. As a result of the study, it was reported that the best effect in aqueous extract was the inhibition zone value of 25 mm at a concentration of 200 mg/mL, and the best effect in the alcohol extract was 17 mm at the concentration of 200 mg/mL [51]. In our study, ethanol and methanol extract of *L. europaeus* were used. As a result of the study, it was seen that the ethanol extract of the plant was effective against *S. aureus*, one of the bacterial strains, at a concentration of 200 µg/mL. It was also determined to be effective against *P. aeruginosa*, *S. aureus* MRSA, *E. faecalis* and *E. coli* at concentrations of 100 µg/mL and against *A. baumannii* at concentrations of 50 µg/mL. Additionally, it was observed that 100 µg/mL was effective against *Candida albicans* and *C. krusei*, and 50 µg/mL was effective against *C. glabrata*. Methanol extract was found to be effective against *S. aureus* and *S. aureus* MRSA, *P. aeruginosa* and *E. coli* at concentrations of 200 µg/mL, and against *E. faecalis* and *A. baumannii* at concentrations of 100 µg/mL. It has also been shown to be effective against *C. albicans, C. glabrata* and *C. krusei* at a concentration of 200 µg/mL. As a result, according to our findings, it is thought that *L. europaeus* can be used as a natural antimicrobial source.

3.4. Anticholinesterase activity

In recent years, the incidence and lethality of neurodegenerative diseases have been increasing. Diseases such as Parkinson's and Alzheimer's are among the most common neurodegenerative diseases. In addition, the incidence of these diseases is higher in people over the age of 65 [52]. In this context, it is thought to reduce the effects of neurodegenerative diseases by using natural products. In our study, acetyl and butyrylcholinesterase activities of ethanol and methanol extracts of *L. europaeus* were determined. The obtained IC50 values are shown in Table 3.

Table 3. Anti-AChE and anti-BChE values of *Loranthus europaeus*

Parameters	Solvents		Standard
	Ethanol	Methanol	Galantamine
AChE (µg/mL)	13.51±0.81	22.79±1.86	9.43±0.46
BChE (µg/mL)	27.84±0.62	33.08±1.63	20.16±0.87

When the literature studies were examined, it was seen that there were no antiocholinesterase studies on *L. europaeus*. In our study, the antiocholinesterase activity of *L. europaeus* was measured for the first time. In our study, it was observed that the IC50 value of the anti-AChE activity of ethanol extract was 13.51 µg/mL, and the anti-AChE activity of methanol extract was 22.79 µg/mL. Among the extracts, ethanol extract had a better value. It was also measured that the anti-AChE activity in both extracts used was lower than that of galantamine used as a control. When studies conducted at the genus level were examined, a study conducted in Bangladesh reported that the AChE inhibition IC50 values of different extracts obtained from the bark part of *L. globosus* were between 64.987-171.533 µg/mL. Additionally, BChE inhibition IC50 values have been reported to be between 85.270-391.633 µg/mL [53]. Compared to this study, it was measured that the anti-AChE activity of both the ethanol extract and methanol extract of *L. europaeus* used in our study was higher. In a study conducted in South Korea, the IC50 value of the methanol extract obtained from the stem part of *L. parasiticus* was reported to be 1542.6 µg/mL [54]. Compared to this study, it was measured that the anti-AChE activity of both the ethanol extract and methanol extract of *L. europaeus* used in our study was higher. In a study conducted in Nigeria, it was reported that the EC50 value of the aqueous extract obtained from the leaf part of *L. bengwensis* was 241.1-390.2 µg/ml [55]. Compared to this study, it was measured that the anti-AChE activity of both the ethanol extract and methanol extract of *L. europaeus* used in our study was higher. As a result, it is thought that *L. europaeus* used in our study may play a role in the treatment of neurodegenerative diseases such as Alzheimer's disease by determining its anticholinesterase activity.

4. Conclusions

Plants are important natural resources. In our study, some biological activities and total phenolic and flavonoid contents of *L. europaeus* were determined. As a result of the analyses, it was determined that the plant has antioxidant, antimicrobial, and anticholinesterase activities. It has been observed that the plant can be a source of phenolics and flavonoids. In this context, it is thought that the plant can be used as an important natural resource in pharmacological designs.

Author Contributions: Author Contributions: Methodology, N.Ç., N.K., I.U., M.S..; investigation, N.Ç., N.K., I.U., M.S..; resources, N.Ç., N.K., I.U., M.S..; statistics, M.A.Y.; writing-original draft preparation, N.Ç., N.K., I.U., M.S., M.A.Y.; writing—review and editing, M.S.; supervision, M.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Mohammed, F. S.; Günal, S.; Şabik, A. E.; Akgül, H.; Sevindik, M. Antioxidant and Antimicrobial activity of *Scorzonera papposa* collected from Iraq and Turkey. *KSÜ Tar. Doga Derg.*, **2020**, *23*(5), 1114-1118. https://doi.org/10.18016/ksutarimdoga.vi.699457
2. Kalkan, M.; Aygan, A.; Çömlekçioglu, N.; Çömlekçioğlu, U. *Olea europaea* Yapraklarının Bazı

Biyoaktif Özelliklerinin Araştırılması, Antimikrobiyal ve Enzim İnhibisyon Etkinliğinin İncelenmesi. *Turkish J. Agri. Food. Sci. Tech.*, **2023**, *11*(3), 496-504. https://doi.org/10.24925/turjaf.v11i3.496-504.5828

3. Comlekcioglu, N.; Dağlı, F.; Çömlekcioğlu, U.; Aygan, A. *Cornus mas* ve *Rosa canina* Meyvelerinin Antioksidan Kapasitesi ve Bazı Fitokimyasal Özellikleri. *Turkish J. Agri. Food. Sci. Tech.*, **2022**, *10*(9), 1724-1731. https://doi.org/10.24925/turjaf.v10i9.1724-1731.5434
4. Mohammed, F. S.; Akgul, H.; Sevindik, M.; Khaled, B. M. T. Phenolic content and biological activities of *Rhus coriaria* var. *zebaria*. *Fresenius Environ. Bull.*, **2018**, *27*(8), 5694-5702.
5. Demirci, A. N.; Çömlekçioğlu, N.; Aygan, A. *Cedrus libani* ve *Pinus nigra* subsp. *pallasiana*'nın Uçucu Yağlarının Kimyasal Bileşimi, Antimikrobiyal Aktivitesi ve Flavonoid İçeriklerinin Belirlenmesi. *Turkish J. Agri. Food. Sci. Tech.*, **2020**, *8*(8), 1747-1754. https://doi.org/10.24925/turjaf.v8i8.1747-1754.3489
6. Doğan, M.; Mohammed, F. S.; Uysal, İ.; Mencik, K.; Kına, E.; Pehlivan, M.; Sevindik, M. Total antioxidant status, antımicrobial and antiproliferative potentials of *Viola odorata* (fragrant vıolet). *J. Fac. Pharm. Ankara*, **2023**, *47*(3), 784-791. https://doi.org/10.33483/jfpau.1161440
7. Sevindik, M.; Mohammed, F. S.; Uysal, I. Autism: plants with neuro-psychopharmacotherapeutic potential. *Prospect. Pharm. Sci.*, **2023a**, *21*(3), 38-48. https://doi.org/10.56782/pps.143
8. Uysal, I.; Mohammed, F. S.; Sevindik, M.; Şabik, A. E.; Sevindik, E.; Dogan, M. Genus *Thymbra*: A Review on Their usage areas, Phytochemical contents and Biological Activities. *Egypt. J. Nutr.*, **2023a**, 38(3), 1-12. https://doi.org/10.21608/enj.2023.209399.1006
9. Mohammed, F. S.; Sevindik, M.; Uysal, İ.; Çesko, C.; Koraqi, H. Chemical Composition, Biological Activities, Uses, Nutritional and Mineral Contents of Cumin (*Cuminum cyminum*). *Measurement: Food*, **2024**, 100157. https://doi.org/10.1016/j.meafoo.2024.100157
10. Uysal, I.; Koçer, O.; Mohammed, F. S.; Lekesiz, Ö.; Doğan, M.; Şabik, A. E.; Sevindik, M. Pharmacological and nutritional properties: Genus *Salvia*. *Adv. Pharmacol. Pharm.*, **2023**, *11*(2), 140-155. https://doi.org/10.13189/app.2023.110206
11. Devasahayam, S.; Rema, J. "Flower birds of Kozhikode District, Kerala". *Newsletter for Birdwatchers*. **1993**, 33(6), 103–105.
12. Jasim, M.; Al-Rubaee, M. A.; Jawad, A.A.D.H. Effects of *Loranthus europeus* seeds on pyogenic inflammation in rabbits. *J. Misan Res.*, **2006**, 2(4), 1-22.
13. Guarino, C.; Simone, L.D. Ethnobotanical Study of the of the Sannio Area, Campania, Southern Italy. *Ethnobot. Res. Appl.*, **2008**, 6, 255-317.
14. Sharquie, K. E.; Noaimi, A. A.; Saleh, B. A. Loranthus europaeus as an alternative medicine in treatment of acute cutaneous Lesihmaniasis. *J. Cosmet. Dermatol. Sci. App.*, **2016**, *6*(1), 24-33. https://doi.org/10.4236/jcdsa.2016.61004
15. Glatzel, G.; Richter, H.; Devkota, M. P.; Amico, G.; Lee, S.; Lin, R.; Barlow, B. A. Foliar habit in mistletoe–host associations. *Botany*, **2017**, *95*(3), 219-229. https://doi.org/10.1139/cjb-2016-0238
16. Lakatos, F.; Mirtchev, S.; Mehemeti, A. Hand book of major forest pests in Southeast Europe. *Food and Agriculture Organization of the United Nations, Pristina*, **2014**, 71-100.
17. Davis, P. H. Flora of Turkey and the East Aegean Islands. **1982**, Vol. 7, 549. Edinburgh University Press
18. Erel, O. A novel automated direct measurement method for total antioxidant capacity using a new generation, more stable ABTS radical cation. *Clin. Biochem.*, **2004**, *37*(4), 277-285. https://doi.org/10.1016/j.clinbiochem.2003.11.015
19. Erel, O. A new automated colorimetric method formeasuring total oxidant status. *Clin. Biochem.*, **2005**, *38*(12), 1103-1111. https://doi.org/10.1016/j.clinbiochem.2005.08.008
20. Sevindik, M. The novel biological tests on various extracts of *Cerioporus varius*. *Fresen. Environ. Bull.*, **2019**, *28*(5), 3713-3717.
21. Bauer, A.W.; Kirby, W.M.; Sherris, J.C.; Turck MAntibiotic susceptibility testing by a standardizedsingle disk method. *Am. J. Clin. Pathol.*, **1966**, *45*, 493-96.
22. Hindler, J.; Hochstein, L.; Howell, A. Preparation of routine media and reagents used in antimicrobial susceptibility testing. Part 1. McFarland standards, p. 5.19.1-5.19.6. In H. D. Isenberg (ed) Clinica lmicrobiology procedures handbook, vol. 1. American Society for Microbiology, Washington, D.C. **1992**
23. Matuschek, E.; Brown, D.F.; Kahlmeter, G. Development of the EUCAST disk diffusionantimicrobial susceptibility testing method and itsimplementation in routine microbiology laboratories. *Clin. Microbiol. Infect.*, **2014**, *20*(4), 255-266. https://doi.org/10.1111/1469-0691.12373
24. Baba, H.; Sevindik, M.; Dogan, M.; Akgül, H. A. S. A. N. Antioxidant, antimicrobial activities and heavy metal contents of some Myxomycetes. *Fresenius Environ. Bull.*, **2020**, *29*(09), 7840-7846.
25. Ellman, G.L.; Courtney, K.D.; Anders, V.J.; Featherstone, R.M. A new and rapid colorimetric determination of acetylcholinesterase activity. *Biochem. Pharm.* **1961**, *7*(88), 951-961. https://doi.org/10.1016/0006-2952(61)90145-9
26. Bal, C.; Eraslan, E. C.; Sevindik, M. Antioxidant, antimicrobial activities, total phenolic and element contents of wild edible mushroom *Bovista nigrescens*. *Prospect. Pharm. Sci.*, **2023**, *21*(2), 37-41. https://doi.org/10.56782/pps.139
27. Korkmaz, N.; Mohammed, F. S.; Uysal, İ.; Sevindik, M. Antioxidant, antimicrobial and anticholinesterase activity of *Dittrichia graveolens*. *Prospect. Pharm. Sci.*, **2023**, *21*(4), 48-53. https://doi.org/10.56782/pps.169
28. Mohammed, F. S.; Kına, E.; Uysal, I.; Sevindik, M. Total phenolic, flavonoid contents, antioxidant and antimicrobial activities of *Hesperis pendula*. *Prospect. Pharm. Sci.*, **2023,** *21*(2), 57-61. https://doi.org/10.56782/pps.135
29. Uysal, I. Total phenolic and flavonoid contents and antioxidant, antimicrobial and antiproliferative activities of *Polycarpon tetraphyllum*. *Kuwait J. Sci.*, **2023**, *50*(3), 322-325. https://doi.org/10.1016/j.kjs.2023.02.022
30. Benabderrahim, M. A.; Elfalleh, W.; Sarikurkcu, C.; Sarikurkcu, R. B. Biological activities and phytochemical composition of organs from *Loranthus*

europaeus. *Ind. Crop. Prod.*, **2019**, *141*, 111772. https://doi.org/10.1016/j.indcrop.2019.111772
31. Rajab, E. S.; Abood, K. W.; Hassn, Z. Y. M. Purification and Identification of Flavonoids Extracted from *Loranthus eurpaeus* Fruits. *J. Biotech. Res. Cent.*, **2016**, *10*(1), 10-15.
32. Katsarou, A.; Rhizopoulou, S.; Kefalas, P. Antioxidant potential of the aerial tissues of the mistletoe *Loranthus europaeus* Jacq. *Rec. Nat. Prod.*, **2012**, *6*(4), 394-397.
33. Bal, C.; Akgul, H.; Sevindik, M.; Akata, I.; Yumrutas, O. Determination of the anti-oxidative activities of six mushrooms. *Fresen. Environ. Bull.*, **2017**, *26*(10), 6246-6252.
34. Krupodorova, T.; Sevindik, M. Antioxidant potential and some mineral contents of wild edible mushroom *Ramaria stricta*. *AgroLife Sci. J.*, **2020**, *9*(1), 186-191.
35. Mohammed, F. S.; Uysal, I.; Yaz, H. H.; Sevindik, M. Papaver species: usage areas, essential oil, nutrient and elements contents, biological activities. *Prospect. Pharm. Sci.*, **2023c**, *21*(4), 1-9. https://doi.org/10.56782/pps.142
36. Gürgen, A.; Sevindik, M. Application of artificial neural network coupling multiobjective particle swarm optimization algorithm to optimize Pleurotus ostreatus extraction parameters. *J. Food Process.*, **2022**, *46*(11), e16949. https://doi.org/10.1111/jfpp.16949
37. Özcandır, A.; Mohammed, F. S.; Sevindik, M.; Aykurt, C.; Selamoglu, Z.; Akgül, H. Phenolic composition, total antioxidant, antiradical and antimicrobial potential of endemic *Glaucium alakirensis*. *Sigma J. Eng. Nat. Sci.*, **2024**, *42*(1), 42-48. https://doi.org/10.14744/sigma.2024.00006
38. Al-Fartosy, A.; Al-Rikaby, A. K. The Antioxidative Action of Monoterpene from Loranthus europaeus L. seeds. *Basrah J. Agric. Sci.*, **2007**, *20*, 322-336.
39. Mohammed, F. S.; Pehlivan, M.; Sevindik, M. Antioxidant, antibacterial and antifungal activities of different extracts of Silybum marianum collected from Duhok (Iraq). *Int. J. Second. Metab.*, **2019**, *6*(4), 317-322. https://doi.org/10.21448/ijsm.581500
40. Akgul, H.; Korkmaz, N.; Dayangaç, A.; Sevindik, M. Antioxidant potential of endemic *Salvia absconditiflora*. *Turkish J. Agri. Food. Sci. Tech.*, **2020**, *8*(10), 2222-2224. https://doi.org/10.24925/turjaf.v8i10.2222-2224.3697
41. Korkmaz, N.; Dayangaç, A.; Sevindik, M. Antioxidant, antimicrobial and antiproliferative activities of Galium aparine. *J. Fac. Pharm. Ankara*, **2021**, *45*(3), 554-564. https://doi.org/10.33483/jfpau.977776
42. Mohammed, F. S.; Pehlivan, M.; Sevindik, E.; Akgul, H.; Sevindik, M.; Bozgeyik, I.; Yumrutas, O. Pharmacological properties of edible *Asparagus acutifolius* and *Asparagus officinalis* collected from North Iraq and Turkey (Hatay). *Acta Aliment.*, **2021**, *50*(1), 136-143. https://doi.org/10.1556/066.2020.00204
43. Mohammed, F. S.; Kına, E.; Sevindik, M.; Doğan, M.; Pehlivan, M. Antioxidant and antimicrobial activities of ethanol extract of *Helianthemum salicifolium* (Cistaceae). *Indian J. Nat. Prod. Resour.*, **2021**, *12*(3), 459-462. https://doi.org/10.56042/ijnpr.v12i3.46635
44. Unal, O.; Eraslan, E. C.; Uysal, I.; Mohammed, F. S.; Sevindik, M.; Akgul, H. Biological activities and phenolic contents of *Rumex scutatus* collected from Turkey. *Fresenius Environ. Bull.*, **2022**, *31*(7), 7341-7346.
45. Sevindik, M.; Akgul, H.; Pehlivan, M.; Selamoglu, Z. Determination of therapeutic potential of *Mentha longifolia* ssp. *longifolia*. *Fresenius Environ. Bull.*, **2017**, *26*(7), 4757-4763.
46. Sevindik, M. Antioxidant and antimicrobial capacity of *Lactifluus rugatus* and its antiproliferative activity on A549 cells. *Indian J. Tradit. Knowl.*, **2020**, *19*(2), 423-427. https://doi.org/10.56042/ijtk.v19i2.35356
47. Eraslan, E. C.; Altuntas, D.; Baba, H.; Bal, C.; Akgül, H.; Akata, I.; Sevindik, M. Some biological activities and element contents of ethanol extract of wild edible mushroom *Morchella esculenta*. *Sigma J. Eng. Nat. Sci.*, **2021**, *39*(1), 24-28.
48. Sevindik, M.; Bal, C.; Eraslan, E. C.; Uysal, I.; Mohammed, F. S. Medicinal mushrooms: a comprehensive study on their antiviral potential. *Prospect. Pharm. Sci.*, **2023b**, *21*(2), 42-56. https://doi.org/10.56782/pps.141
49. Ali, A. I. D. Y.; Bahmani, M.; Pirhadi, M.; Kaviar, V.; Karimi, E.; Abbasi, N. Phytochemical analysis and antimicrobial effect of essential oil and extract of *Loranthus europaeus* Jacq. on *Acinetobacter baumannii, Staphylococcus aureu*s, and *Pseudomonas aeruginosa*. *Kafkas Univ. Vet. Fak. Derg.*, **2022**, *28*(2), 161-167. https://doi.org/10.9775/kvfd.2021.26626
50. Ambrosio, R. L.; Gratino, L.; Mirino, S.; Cocca, E.; Pollio, A.; Anastasio, A.; Gogliettino, M. The bactericidal activity of protein extracts from Loranthus europaeus berries: a natural resource of bioactive compounds. *Antibiotics*, **2020**, *9*(2), 47. https://doi.org/10.3390/antibiotics9020047
51. Yaseen Hasan, A.; Ismael, T. K. Antimicrobial activity of *Loranthus europaeus* L. and *Lawsonia inermis* L. extracts against clinical Methicillin-resistant *Staphylococcus aureus* isolated from boil infections. *Tikrit J. Pure Sci.*, **2018**, *23*(6), 24-30. http://dx.doi.org/10.25130/tjps.23.2018.084
52. Świątek, Ł.; Sieniawska, E.; Sinan, K. I.; Maciejewska-Turska, M.; Boguszewska, A.; Polz-Dacewicz, M.; Senkardes, I.; Guler, G.O.; Sadeer, N.B.; Mahomoodally, M.F.; and Zengin, G. LC-ESI-QTOF-MS/MS Analysis, Cytotoxic, Antiviral, Antioxidant, and Enzyme Inhibitory Properties of Four Extracts of *Geranium pyrenaicum* Burm. f.: A Good Gift from the Natural Treasure. *Int. J. Mol. Sci.*, **2021**, *22*(14), 7621. https://doi.org/10.3390/ijms22147621
53. Kundo, N. K.; Manik, M. I. N.; Biswas, K.; Khatun, R.; Al-Amin, M. Y.; Alam, A. H. M. K.; Sadik, G. Identification of polyphenolics from *Loranthus globosus* as potential inhibitors of cholinesterase and oxidative stress for Alzheimer's disease treatment. *BioMed Res. Int.*, **2021**, ttps://doi.org/10.1155/2021/9154406
54. Weon, J. B.; Lee, J.; Eom, M. R.; Jung, Y. S.; Ma, C. J. The effects of Loranthus parasiticus on scopolamine-induced memory impairment in mice. *Evid. Based. Complement. Alternat. Med.*, **2014**, https://doi.org/10.1155/2014/860180
55. Omojokun, O. S.; Oboh, G.; Ademiluyi, A. O. Effects of drying on cholinesterases and angiotensin-I converting enzyme inhibitory potential and phenolic constituents of African mistletoe (*Loranthus bengwensis* L) leaves from kolanut host tree. *J. Food Biochem.*, **2018**, *42*(4), e12510. https://doi.org/10.1111/jfbc.12510