

Antibacterial activities of *Erodium pelargoniiiflorum* Boiss. & Heldr.

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ABSTRACT

This study aimed to analyse the antibacterial activity of *Erodium pelargoniiiflorum* against the following bacteria: *Staphylococcus aureus* (ATCC 6538), *Enterococcus faecalis* (ATCC 29212), *Escherichia coli* (ATCC 8739), *Salmonella* Typhimurium (ATCC 14028) and *Staphylococcus epidermidis* (ATCC 12228). Dichloromethane, methanol and ethyl acetate extracts were obtained from parts (roots, flowers and aerial) of *E. pelargoniiiflorum*. The antibacterial activity analyses were carried out by disc diffusion method. In accordance with the findings, the aerial parts of *E. pelargoniiiflorum* showed the greatest inhibitory effect against *S. epidermidis*. After an evaluation of the antibacterial activity results in relation to the plant parts revealed that the roots exhibited a more extensive spectrum of antibacterial activity, contingent on the extraction solvent and microorganism type. This study investigated the antibacterial activities of *E. pelargoniiiflorum* for the first time. The need is for further studies for the identification and isolation of the bioactive chemical compounds responsible for these effects.

Keywords: *Erodium pelargoniiiflorum*, antibacterial activity, Geraniaceae, extract

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INTRODUCTION

Every year, millions of people die from microbial infections around the world. Furthermore, resistance to antibiotic drugs is a major challenge that endangers public health¹. The excessive utilisation of antimicrobials has resulted in the development of selective pressures and caused resistance to currently available antibiotics².

The global increase in antimicrobial resistance means that new approaches are needed more than ever. Therefore, researchers constantly conduct research into the antimicrobial activity of naturally occurring compounds³. Plants offer significant promise as a source of new antimicrobial agents. It is well known that medicinal plants are very effective in treating infectious diseases⁴.

Erodium L'Hér., a genus in the Geraniaceae family, is a well-known genus comprising 129 accepted species that are distributed across many continents^{4,5}. The Mediterranean Basin region is where most of these species are found^{4,6}. *Erodium* is represented by 26 species in Turkey and known as "Dönbaba"⁷⁻¹⁰.

Due to the rich essential oil content of many species in the Geraniaceae family, they are widely used for medicinal purposes and in the cosmetics industry. There are numerous studies on their phytochemicals and biological activities. However, there are very few studies about *Erodium* genus in this regard¹¹. *Erodium* species were reported to contain phenolic compounds and alkaloids and to have antimicrobial, anti-inflammatory, antioxidant, cytotoxic, and enzyme inhibitory activities¹²⁻¹⁵. The genus is utilised in the context of folk medicine for the treatment of numerous ailments including indigestion and inflammatory diseases, dermatological and gastrointestinal disorders, constipation, diabetes, cancer, eczema, and hemorrhages. Also it is used as a carminative agent, an astringent, and an antiseptic¹⁶. The use of the plant in Iraq is twofold: as a treatment for dysentery and abdominal pain, and for snake and scorpion bites. Moreover, salads, omelettes, sandwiches, sauces, soups, and some food products have been prepared using its leaves¹⁶⁻¹⁹.

This study purposed to analyse the antibacterial efficacy of dichloromethane (DCM), methanol (MeOH) and ethyl acetate (EtOAc) extracts from the parts (roots, flowers and aerial) of *E. pelargoniiiflorum*.

METHODOLOGY

Plant material

E. pelargoniiiflorum was collected from Karaman-Ermenek in June 2023 and identified by Ömer Çeçen. A voucher specimen (KNYA 30375) was deposited in the Selçuk University Herbarium (KONYA/TÜRKİYE).

Test microorganisms

Test microorganisms used in the present study were *S. aureus* (ATCC 6538), *Enterococcus faecalis* (ATCC 29212), *E. coli* (ATCC 8739), *Salmonella* Typhimurium (ATCC 14028) and *S. epidermidis* (ATCC 12228). These were supplied by the Microorganism Culture Collection at the School of Pharmacy, Department of Pharmaceutical Microbiology, Istanbul Medipol University.

Preparation of extracts

The dried and powdered roots, flowers, and aerial parts of *E. pelargoniiiflorum* were sequentially extracted at room temperature with EtOAc, MeOH and DCM. The extracts were separately concentrated in a rotary evaporator. This was done under reduced pressure to dryness.

Antibacterial efficacy determination of extracts

20 mg of extract was dissolved in 1 mL of dimethyl sulfoxide (DMSO)-H₂O (1:9) v/v and was mixed with vortex. The disc diffusion method was used for the assessment of the antibacterial efficacy of the extracts²⁰. A bacterial suspension was obtained from 24h bacterial culture, then bacterial suspension adjusted to 0.5 McFarland. Sterile discs were impregnated with 20 µL of extracts (20 mg/mL). Bacterial suspension was inoculated to Mueller Hinton Agar plates using swabs. Then, the impregnated discs were gently pressed onto the inoculated Mueller Hinton Agar plates. The incubation was conducted at a temperature of 37°C for 24h. After the incubation period, the diameters of inhibition zone (IZs) were measured. Antibiotic disc (Amoxicillin 25µg) that is commercially available was used as a positive control. DMSO-H₂O (1:9) v/v impregnated disc was used as a negative control. Experimental procedures were carried out three times under aseptic conditions and IZs were calculated as an average of these three repetitions.

RESULTS and DISCUSSION

This investigation involved the antibacterial activity analyses of DCM, EtOAc and MeOH extracts obtained from parts (roots, flowers and aerial) of *E. pelargoniiiflorum*. Table 1 showed the inhibition zone diameters of *E. pelargoniiiflorum* extracts against test microorganisms. The aerial parts of *E. pelargoniiiflorum* exhibited the greatest inhibitory effect against *S. epidermidis* (ATCC 12228) with 20.36 ± 0.45 mm inhibition zone diameter. It was found that methanol extracts of parts (roots, flowers and aerial) of *E. pelargoniiiflorum* had antibacterial activity on *S. aureus* (ATCC 6538) and *S. epidermidis* (ATCC 12228). The extracts have showed no antibacterial activity against *E. coli*. Only

the methanolic extract of roots exhibited antibacterial activity against *E. faecalis* (ATCC 29212). DCM, EtOAc and MeOH extracts of aerial parts and roots showed antibacterial activity against *S. epidermidis* (ATCC 12228). In addition to this, DCM, EtOAc and MeOH extracts of roots exhibited antibacterial activity against *S. aureus* (ATCC 6538). When the antibacterial activity results were evaluated in terms of plant parts, it was observed that the root part had a broader spectrum of antibacterial activity in terms of extract solvent and microorganism type.

Table 1. Inhibition zone diameters of *E. pelargoniflorum* extracts against test microorganisms

<i>E. pelargoniflorum</i>	Extract (400µg/disc)	Test Microorganisms				
		<i>S. aureus</i> (ATCC 6538)	<i>E. faecalis</i> (ATCC 29212)	<i>S. epidermidis</i> (ATCC 12228)	<i>E. coli</i> (ATCC 8739)	<i>S. Typhimurium</i> (ATCC 14028)
		inhibition zone diameters (mm)				
Aerial parts	DCM	0/0/0	0/0/0	7.10 ± 0.22	0/0/0	8.4 ± 0.06
	EtOAc	0/0/0	0/0/0	6.8 ± 0.62	0/0/0	8.41 ± 0.19
	MeOH	16.99 ± 0.33	0/0/0	20.36 ± 0.45	0/0/0	0/0/0
Flowers	DCM	0/0/0	0/0/0	0/0/0	0/0/0	6.97 ± 0.86
	EtOAc	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
	MeOH	16.63 ± 0.39	0/0/0	18.64 ± 0.75	0/0/0	0/0/0
Roots	DCM	8.94 ± 0.67	0/0/0	7.13 ± 1.31	0/0/0	0/0/0
	EtOAc	10 ± 0.41	0/0/0	13.52 ± 0.59	0/0/0	6.54 ± 0.41
	MeOH	10.04 ± 0.33	6.5 ± 0.35	12.64 ± 0.45	0/0/0	0/0/0
Positive control	Amoxicillin (25µg)	19.17 ± 0.79	17 ± 0.5	28.53 ± 0.5	20.8 ± 0.2	20.43 ± 0.6
Negative control	DMSO-H ₂ O	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0

Samet and colleagues (2022) conducted a study investigating the antimicrobial activities of *Erodium arborescens* against six different pathogenic microorganisms (*E. coli*, *L. monocytogenes*, *P. aeruginosa*, *S. Typhimurium*, *S. aureus*, *C. albicans*). It has been stated that the hexane extract demonstrated moderate inhibitory activity against *L. monocytogenes*, *P. aeruginosa*, *S. enterica* Typhimurium and *E. coli*. It was also demonstrated that extracts of ethyl acetate and acetone exhibited significant efficacy all tested bacteria and the

fungus *C. albicans*. The most strong activity was observed against *P. aeruginosa*, with an inhibitory zone diameter of 28 and 30 mm for the ethyl acetate and acetone extracts, respectively. The methanol extract demonstrated significant inhibitory activity against only *P. aeruginosa*, *S. enterica* Typhimurium, *E. coli*, and the fungus *C. albicans*⁴.

In a study that evaluated the *in vitro* antimicrobial activity of *Erodium cicutarium* water and methanolic extracts from four locations in Croatia against *S. aureus* ATCC 6538, Methicillin-Resistant *S. aureus* (MRSA), Methicillin Sensitive *S. aureus* (MSSA), *P. aeruginosa* ATCC 27853 and *C. albicans* ATCC 90028 was conducted by Ljoljić Bilić and colleagues. They stated that the obtained results confirmed that *E. cicutarium*, which has a profiled and rich phytochemical composition, is a plant species with both an ethnopharmacological value and *in vitro* antimicrobial activity³.

The antibacterial activities of the aqueous and methanolic extracts of *E. guttatum* against *E. coli*, *S. Typhimurium*, *P. aeruginosa*, *K. pneumoniae*, *S. aureus*, and *L. monocytogenes* were examined by disc diffusion and broth dilution methods in a study that conducted by Mrabti and colleagues. The findings of the study indicated that the methanolic extract was more effective on the tested bacteria¹⁶.

This study investigated the antibacterial activities of *E. pelargoniflorum* for the first time. The findings of the investigation revealed that the aerial parts of *E. pelargoniflorum* exhibited the most significant inhibitory effect against *S. epidermidis* (ATCC 12228). Following a thorough evaluation of the antibacterial activity results in relation to the plant parts, it was concluded that the roots exhibited a more extensive spectrum of antibacterial activity depending on extraction solvent and microorganism type. Further studies are required in order to identify and isolate the bioactive chemical compounds that are responsible for the observed effects. The antiviral and antifungal activities of the roots, flowers and aerial parts of *E. pelargoniflorum* should also be investigated.

STATEMENT OF ETHICS

This study does not require any ethical permission.

CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

AUTHOR CONTRIBUTIONS

AH contributed to conceptualization, methodology, investigation, data curation, visualization, formal analysis, original draft writing, and review and editing. AÇ contributed to investigation, formal analysis, visualization, and review and editing. ÖÇ contributed to methodology, materials, and investigation. FT contributed to conceptualization, methodology, and original draft writing.

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