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Research Article

Studying of antimicrobial activities of resins and ether parts of resins of *Ferula tadshikorum*

Dildora Barakaeva[1*], Farkhod Eshboev[2], Nuriddin Mukarramov[2], Salima Aripova[2], Damir Mansurov[2] and Shakhnoz Azimova[2]

[1]Tashkent state Agrarian University;
[2]S.Yu. Yunusov Institute of the Chemistry of Plant Substances, Academy of Sciences of the Republic of Uzbekistan, 77, Mirzo Ulugbek Str., 100170, Tashkent, Uzbekistan;
*Correspondence: barakayevadildora0@gmail.com

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Abstract

In this study, antimicrobial activities of resins and ether parts of resins of *Ferula tadshikorum* were investigated. Ether parts of resin showed potential antimicrobial activities (13,5±0.15 mm - 16.21±0.12 mm). Therefore, the chemical contents of volatile parts of resin were determined by the GC-MS method in order to identify the major compounds responsible for the observed antimicrobial activity (Table 2). The chemical composition of the volatile fraction of *F. tadshikorum* ether has been studied in several research papers. The composition of the volatile fraction can vary depending on factors such as the geographic location and harvesting time of the plant, as well as the extraction method used.

Keywords: *Ferula tadshikorum*, antimicrobial activity, GC-MS method, resin, ether.

Introduction.

The genus *Ferula* is the third largest and well-known genus of the family *Apiaceae* - celery. Currently, about 180 species of *Ferula* are known. The genus is distributed mainly throughout Central and Southwest Asia (especially in Iran and Afghanistan), the Far East, Northern India and the Mediterranean. The genus *Ferula* is characterized by the presence of oil resins (asafoetida, sagapenum, galbanum) and their use in folk and traditional pharmaceuticals [1]. *Ferula* is a Latin word meaning "vehicle" or "carrier". The main phytochemicals present in plants of the genus *Ferula* are coumarins, coumarin esters, sesquiterpenes, sesquiterpene lactones, monoterpenes, monoterpene coumarins, prenylated coumarins, sulfur-containing compounds, phytoestrogens, flavonoids, carbohydrates and other compounds [2]. This genus is distinguished by the content of valuable groups of chemical compounds in medicinal plant species, namely, the content of odorous volatile components as essential oils, which cause their widespread use for various biological and pharmacological purposes. Numerous biological activity of chemical components of

essential oils obtained from various varieties of plant species of the genus *Ferula* is known. Since this genus includes many bioactive substances that exhibit antimicrobial, insecticidal, antioxidant, cytotoxic and other types of activity, scientists are currently focusing their research on plants of this genus.

Species of the genus *Ferula* have been used in folk and traditional medicine for more than 1000 years. The genus *Ferula* is characterized by oleo-gum resin, their essential oils, which include a large number of valuable natural compounds, can be considered as liquids that are lighter than water and have remarkable hydrophobic characteristics [3]. Essential oil obtained from species of the genus *Ferula* exhibits various types of biological activity such as antimicrobial, antioxidant, anti-inflammatory and etc. [4,5]. These properties are related and conditioned by the chemical group of substances present in essential oils, and the activity can also be associated with one compound or a group of chemical compounds similar in structure contained in essential oil. Therefore, the aim of the study was the study of antimicrobial activities of resins and ether parts of resins of *Ferula tadshikorum.*

Material methods.

Antimicrobial activities

The ethers and resins of *Ferula tadshikorum* were tested for antimicrobial activity by the agar disk-diffusion method [6]. The antimicrobial activity was evaluated using the following five microorganism: Gram-negative bacteria *Escherichia coli* and *Pseudomonas aeruginosa*; Gram-positive bacteria *Bacillus subtilis* and *Staphylococcus aureus*; the yeast *Candida albicans*. Sterile nutrient agar (28 g agar/l distilled water) was inoculated with bacterial cells (200 µl of bacterial cells in 2 ml 0.9% NaCl suspension and 25 ml medium) and poured into Petri dishes to give a solid medium. *Candida albicans* (1×106 colony forming units per ml) was inoculated into sterile Mueller-Hinton-agar. The 2 mg/per disk of samples were applied on sterile paper disks. Ampicillin/Sulbactam (10 µg+10 µg disc), gentamicin (10 µg/disk), and fluconazole (25 µg/disk) were used as positive controls and the solvents as negative controls.

The solvents were allowed to evaporate in a stream of air. The disks were deposited on the surface of inoculated agar plates. Plates were kept for 2 h in the refrigerator to enable the diffusion of the substances into the agar. Plates with bacteria were incubated for 24 h at 37°C and plates with *Candida albicans* for 48 h at 28 °C. The inhibition zone diameter was measured and recorded after the incubation time. An average zone of inhibition was calculated for the three replicates in independent assays.

Determination of chemical content of volatile ether fraction of *Ferula tadshikorum*

In this research work, the chemical composition of the volatile resin fraction of *Ferula tadshikorum* roots was studied using the GC-MS method on the MSD/7890A GC System Agilent Technologies USA LTD chromatography-mass spectrometer. It is established that the main chemical components of this sample are 12 substances. The detected substances were identified by comparison with data from the Wiley Mass Spectrum Library (Wiley W9N11.L and NIST version 2.0) (Table 1.).

Statistical analysis

Statistical analysis and exponential curve fitting were performed using Origin 8.6 software (Microcal Software Inc., Northampton, MA). Results were expressed as mean ± SE. To determine the statistical significance of the results One-Way ANOVA was per-formed.

Results and discussion

The essential oil of *F. tadshikorum* is obtained by steam distillation of the plant's dried roots. The oil is rich in terpenes, including α-pinene, β-pinene, limonene, and β-phellandrene. It also contains sesquiterpenes, such as β-caryophyllene and germacrene D. The essential oil of *F. tadshikorum* has been shown to possess antimicrobial, antifungal, antioxidant, and anti-inflammatory properties. The resin of *F. tadshikorum* is obtained by making incisions in the plant's stem and collecting the exudate. The resin contains a mixture of compounds,

including polysaccharides, coumarins, and sesquiterpene lactones. The resin has been shown to possess antimicrobial, antifungal, and antioxidant properties [7].

Some studies have suggested that the essential oil and resin of *F. tadshikorum* may have potential therapeutic applications in the treatment of various health conditions, such as fungal infections, inflammation, and oxidative stress [8]. However, further research is needed to fully understand the potential health benefits of these compounds. Therefore, the antimicrobial activities of ethers and resins of this plant were carried out. It is interesting to note that, only the ethers of *F. tadshikorum* exhibited antimicrobial activities against the tested microorganisms, while the resin did not show any activity. The ethers showed significant activity (13,5±0.15 mm - 16.21±0.12 mm) against all tested microorganisms except for *Pseudomonas aeruginosa*, which was less susceptible to the compounds. The results suggest that the ethers of *F. tadshikorum* may have potential as antimicrobial agents, although further studies are needed to determine their chemical content, mechanism of action and potential therapeutic applications. It is also important to note that the results of this study may not necessarily apply to other varieties or sources of *F. tadshikorum*, as the chemical composition of the plant can vary depending on factors such as geographic location, climate, and harvesting methods.

Table 1. Antimicrobial activities of ethers and resins of *F. tadshikorum*

№	Samples	Inhibition zone (mm, ±SE, p≤0.05)				
		Gramm-positive bacteria		Gramm-positive bacteria		Fungus
		B. subtilis	*S. aureus*	*E. coli*	*P.aeruginosa*	*C. albicans*
1	Danak resin	N/A	N/A	N/A	N/A	N/A
2	Xolva resin	N/A	N/A	N/A	N/A	N/A
3	Shira resin	N/A	N/A	N/A	N/A	N/A
4	Ether part of resin	13,5±0.15	16.21±0.12	15.25±0.11	8.5±0.1	16.0±0.14
	Ampicillin/Sulbactam (10 µg+10 µg disc)	35.5±	35.25±0.14	-	-	
	Gentamicin (10 µg/disc)	-	-	18.5±0.5	25.3±0.12	
	Fluconazole (25 µg/disc)	-	-	-	-	30.3±0.5

In the study, the chemical composition of the ether fractions was analyzed using GC-MS in order to identify the major compounds responsible for the observed antimicrobial activity (Table 2). The chemical composition of the volatile fraction of *F. tadshikorum* ether has been studied in several research papers. The composition of the volatile fraction can vary depending on factors such as the geographic location and harvesting time of the plant, as well as the extraction method used.

Table 2. The chemical composition of the volatile fraction of *F. tadshikorum* ether part of resin determined by the GC-MS method

№	RT	Area%	Library/ID	CAS # №	Quality
1.	7.050	2.20	Propane, 1-[(methylethyl)thio]2-(Isopropyldisulfanyl) butane Propyl n-butyl disulfide	005008-73-1 067421-86-7 072437-64-0	32 25 22
	7.943	15.13	1,2-Dithiolane [1,3]Dihian-2-one Thiirane, methyl-	000557-22-2 035345-24-5 001072-43-1	43 16 12
3.	8.460	27.32	1,2-Dithiolane [1,3]Dihian-2-one 1,3-Dithiolane	000557-22-2 035345-24-5 004829-04-3	43 38 35

4.	17.963	2.88	Thiazole, tetrahydro- Methanethioamide, N,N-dimethyl-Thiopropionamide	000504-78-9 000758-16-7 000631-58-3	53 50 50
5.	18.526	0.59	Silane, [(methylsilyl) methyl] (silylmethyl)- Propane, 2-methyl-1-(propylthio)-ether, bis [2-(ethylthio)ethyl]	005695-49-8 001741-84-0 005648-30-6	58 50 39
6.	18.991	27.28	Methyl-d3 2-methyl-2-propenyl Ether Methyl 1-methyl-d3-2-propenyl Ether Thiazolidine Tetrahydrothiazole 1-Thia-3-azacyclopentane	998005-37-5 998005-38-1 000504-78-9	78 59 59
7.	19.392	20.33	Methyl 2-(methlthio) butyrate Carbonodithioic acid, S,S-diethyl ester Thiopropionamide	051534-66-8 000623-80-3 000631-58-3	50 50 47
8.	28.461	0.63	1-Tripropylsilyloxycyclopentane Germacyclopent-3-ene, 1,1,3,4-tetramethyl-d-ribo-hexos-3-ulose	1000279-13-2 005764-66-9 002092-61-7	50 40 39
9.	40.519	0.29	n-Hexadecanoic acid Pentafluoropropionic acid, tetradecyl ester 5-octadecane (E)	000057-10-3 006222-06-6 007206-21-5	46 38 30
10.	44.911	0.31	2-octylcyclopropene-1-heptanol 9-Eicosyne 9,12-Tetradecadien-1-ol, acetate, (Z,E)	054467-85-5 071899-38-2 031654-77-0	30 30 30
11.	45.021	0.86	Cyclododecane 1-Dodecane alpha –Dodecane n-Dodec-1-ene, Dodec-1-ene	000294-62-2 000112-41-4	87 83
12.	46.257	2.18	9,12-Octadecadienoic acid (Z,Z)- cis-9, cis-12-Octadecadienoic acid, 1-pentadecyne, 2-hydroxy-1-(hydroxymethyl) ethyl ester	000060-33-3 000765-13-9 003443-82-1	96 91 91

The relative amounts of these compounds can vary depending on the specific sample of *F. tadshikorum* ether analyzed. It is important to note that the volatile fraction of the ether is complex and contains many other compounds in addition to those listed above.

Conclusion:

In conclusion, it was found that resins isolated from *F. tadshikorum* plant do not have antimicrobial activity. However, it was found that the volatile substances contained in the resins have high antimicrobial activity. Therefore, the ether part of resins isolated from *F. tadshikorum* plant can be used as potential antimicrobial substances.

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