CHEMICAL COMPOSITION AND ANTIMICROBIAL ACTIVITY OF VOLATILE ESSENTIAL OIL FROM THE FLOWER PART OF *FERULA FERGANENSIS*

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Annotation: This study aimed to determine the chemical composition of the essential oil extracted from the flower of *Ferula ferganensis* and to evaluate its antimicrobial potential. Since ancient times, *Ferula ferganensis* has been known as a medicinal plant and used for medicinal purposes. Even Avicenna wrote about it as an effective remedy against worms. It is noted that there are large reserves of *F.ferganensis* in some mountainous regions of Kyrgyzstan. As a result of gas chromatography-mass spectrometry (GC-MS) analysis of essential oil obtained by hydrodistillation from *F.ferganensis* flowers, 59 compounds were identified.

Key words: *Ferula ferganensis*; flowers; Essential oil; composition; determined; Antibacterial activity; Antifungal activity; GC-MS.

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FERULA FERGANENSIS O‘SIMLIGI GUL QISMINING UCHUVCHAN EFIR MOYI KIMYOVIY TARKIBI VA MIKROBLARGA QARSHI FAOLLIGI.

Annotatsiya: Ushbu tadqiqot *Ferula ferganensis* gulidan olingan efir moyining kimyoviy tarkibini aniqlash va uning mikroblarga qarshi salohiyatini baholashga qaratilgan. Qadim zamonlardan beri *Ferula ferganensis* dorivor o'simlik sifatida tanilgan va dorivor maqsadlarda ishlatilgan. Hatto Avitsenna ham bu haqda, qurtlarga qarshi samarali vosita sifatida yozgan. Qirg‘izistonning ayrim tog‘li hududlarida *F.ferganensisning* katta zahiralari borligi qayd etilgan. *F.ferganensis* gullaridan gidrodistillash yo‘li bilan olingan efir moyini, gaz xromatografiya-mass-spektrometriya (GK-MS) usulida tahlil qilish natijasida 59 ta birikma aniqlandi.

Kalit so‘zlar: *Ferula ferganensis*; gullar; Efir moyi; tarkibi; aniqlangan; Antibakterial faollik; Antifungal faoliyat; GC-MS.

ХИМИЧЕСКИЙ СОСТАВ И АНТИМИКРОБНАЯ АКТИВНОСТЬ ЛЕТУЧЕГО ЭФИРНОГО МАСЛА ИЗ ЦВЕТОЧНОЙ ЧАСТИ *FERULA FERGANENSIS*

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Аннотация: Целью данного исследования было определение химического состава эфирного масла, выделенного из цветков *Ferula ferganensis*, и изучения его антимикробного потенциала. С древних времен *Ferula ferganensis* была известна как лекарственное растение и использовалась в лечебных целях. Еще Авиценна писал о ней как об эффективном средстве против глистов. Отмечено, что в некоторых горных районах Кыргызстана имеются большие запасы *F.ferganensis*. В результате анализа методом газовой хроматографии-масс-спектрометрии (ГХ-МС) эфирного масла, полученного гидродистилляцией из цветков *F.ferganensis*, было идентифицировано 59 соединений.

Ключевые слова: *Ferula ferganensis*; цветки; Эфирное масло; состав; определено; Антибактериальная активность; Противогрибковая активность; ГХ-МС.

Introduction. Medicinal plants belonging to the genus *Ferula* (family *Apiaceae*) have long been used for medicinal purposes. To this day, *Ferula* is traditionally used in many countries to treat various diseases such as asthma, stomach ache, flatulence, intestinal parasites, indigestion and influenza. The family *Apiaceae* is rich in secondary metabolites, namely monoterpenes, sesquiterpenes and phenylpropanoids. More than 180 chemical constituents, sulfur-containing metabolites, terpenoids, coumarins, sesquiterpene coumarins, aglycones and glycosides, and their biological activities have been reported. The chemical constituents of essential oils from different *Ferula* species show a wide range of biological activities. Researchers are currently focusing on this species because it contains many bioactives such as antimicrobial, insecticidal, antioxidant, cytotoxic, etc. The chemical composition of the volatile essential oil of *F.ferganensis* has not been studied so far, and there is little information about the composition of the volatile essential oil. Thus, the chemical composition of the essential oil from *F.ferganensis*, as well as its biological activity, was investigated for the first time in this study.

Literatures analysis. This study aimed to determine the chemical composition of the essential oil extracted from the flower of *Ferula ferganensis* and to evaluate its antimicrobial potential. It is noted that there are large reserves of *F.ferganensis* in some mountainous regions of Kyrgyzstan. As a result of gas chromatography-mass spectrometry (GC-MS) analysis of essential oil obtained by hydrodistillation from *F.ferganensis* flowers, 59 compounds were identified. The main components of the essential oil extracted from the flower of *F.ferganensis* were found to be *α*-Phellandrene, Z-Ocimene, *α*-Terpinolene, Benzaldehyde and Cariophyllene. The chemical composition of essential oils of *F.ferganensis* flowers was studied for the first time and their activity was checked.

Ferula species have long been used in traditional medicine to treat many diseases. The perennial flowering plants of *Ferula L*. are one of the largest genera

of the *Apiaceae (Umbelliferae*) family, More than 185 species are distributed around the world, 104 species in Central Asian republics, and 50 species in our country [1]. *Ferula* grows in the sandy deserts, hills, mountains and foothills of our Republic, in Tashkent, Surkhandarya, Kashkadarya, Jizzakh, Navoi, Bukhara regions and the Republic of Karakalpakstan [2].

Currently, natural synthesis products are widely used in the development of medicine. Naturally synthesized plant products are rich in unique chemical diversity (phenol derivatives, terpenoids, alkaloids, coumarins, lipids, carbohydrates, proteins, vitamins and other metabolites). The widespread use of plants in their natural form and their ease of use are related to the effectiveness of various antibacterial and antifungal methods of action [3]. Species of the genus *Ferula* are distributed mainly in mountainous regions, some in arid climates. Some species are commonly used as spices. *Ferula* genus is mainly characterized by the presence of sesquiterpenes and sesquiterpene coumarins, phenolic derivatives [4]. Members of the *Apiaceae* generally have a distinctive pungent odor. This is related to the formation of essential oil or oleoresin in their various organs, and is in great demand in the study of the chemical composition of essential oil [5]. Therefore, essential oils of *Apiaceae* plants are widely used in aromatherapy. *Ferula* is a perennial plant. So far, more than 70 species of this species have been phytochemically investigated [6]. It has been analyzed that part of the biological activity of these types of plants depends on their essential oils. These volatile components are mainly synthesized by the secondary metabolites of aromatic plants and act as part of the plant's defense system against bacterial, viral, fungal and insect attacks [7]. The history of the use of essential oils in various directions, as medicine, goes back to ancient times. It is mainly used in food, sanitation, medicine, for its aromatic and medicinal properties [8]. In recent decades, phytochemical analyzes for the volatile components of many aromatic plants have been carried out, and the results have revealed a great qualitative and quantitative diversity in the composition of essential oils [9]. The main constituents of essential oils are small and lipophilic molecules, consisting mainly of homoterpene,

monoterpene and sesquiterpene compounds [10]. Most of these phytochemical species are bioactive. Antioxidant and antimicrobial properties are among the most popular [11]. Therefore, we investigated the volatile components of essential oils from *F.ferganensis* species and investigated their antimicrobial properties. In order to search for biologically active compounds, the composition of essential oil from the flower part of *F.ferganensis* collected during the flowering period was studied.

Materials and methods. Collection and Identification of *Ferula ferganensis* *F.ferganensis* fresh flowers, collected in mid-June 2022 in the Ala-Too Range, in the Suusamyr valley of Kyrgyz Republic.

Extraction of *F.ferganensis* Essential Oil The volatile essential oil was extracted from 100 g of wet flowers by hydrodistillation at atmospheric pressure for 3 hours.

GC-MS Analysis of *F.ferganensis* Essential Oil. The essential oil dissolved in CH_2Cl_2 was dried over anhydrous Na_2SO_4 and the essential oil was stored at 4 ^{0}C before analysis. The volume of fat was 0.4%. The quantitative composition of the essential oil was determined on an Agilent 5975c Inert MSD/7890A GC-MS. (Agilent Technologies, USA). GC-MS analytical conditions were similar to those in the literature. Voters were determined by comparing mass-spectral characteristics with data in electronic libraries. Retention indices (RI) were determined by comparing the ratio of retention times of mixtures of n-alkanes (C_9–C_{30}) and comparing them with those in the literature.

Experiment part: Antimicrobial Activity of *F.ferganensis* Essential Oil. Antibacterial activity. Test strains (*S. aureus-91, B. subtilis-5, P. aeruginosa-225, E. coli-221 C. albicans-247*) were used to determine the antimicrobial activity of *F.ferganensis* essential oils. The disc diffusion method was used to determine the antimicrobial activity of essential oils.

Results and discussion. Essential oil analysis: 59 components were identified by GC-MS in the essential oil obtained from the flower part of *F.ferganensis*, which accounts for 93.85% of the oil mass. It was found that the volatile essential oil contained in the flower of *F.ferganensis* is a rich source of

terpenes, which included monoterpene hydrocarbons (58.08%), oxidized monoterpenes (17.29%), sesquiterpene hydrocarbons (11.24%) and other substances (7.24%).

The main components of the essential oil are: α-Phellandrene (16.5%), (E)-α-Ocimene (14.9%), α-Terpinolene (12.8%), Benzaldehyde (11.3%), Caryophyllene (8.2%), D-Limonene (5.7%), Bornyl acetate (3.0%), Sabinene (2.8%), Germacrene-D (2.34%), Bicyclogermacrene (2.0%), *β*-Ocimene (1.4%), Osthole (1.2%), γ -Terpinene (1.1%)**(Table 1).**

Table 1

Chemical compositions of essential oil flowers of *F.ferganensis*

Constituent	RI	Content %	Constituent	RI	Content %
δ-3-Carene	1144	0.36	1,8-menthadien-4-ol	1652	0.08
1-Phellandrene	1162	16.52	2(5H)-Furanone	1661	0.58
α –Terpinene	1170	0.08	Camphene	1665	0.17
d-Limonene	1256	5.73	Germacrene-D	1677	2.34
Sabinene	1203	2.80	Biciclogermacrene	1699	2.03
cis-Ocimene	1596	14.90	Berbenol	1708	0.51
γ –Terpinene	1234	1.10	*β* –cadinene	1723	0.18
β-Ocimene	1240	1.45	Benzene	1765	0.04
p-Cymene	1252	0.85	Germacrene-B	1785	0.30
α –Terpinolene	1273	12.82	p-Cymen-8-ol	1807	0.15
2-Buten-1-ol	1298	0.15	1,4-Cyclohexadiene	1834	0.23
1-Hexanol	1331	0.02	Benzaldehyde	1846	0.75
Alloocimene	1354	0.34	Phenylethyl Alcohol	1856	0.05
Phenol	1363	0.09	5-Ethylcyclopent-1-enecarboxaldehyde	1879	0.03
1,3,8-Menthatriene	1369	0.03	Bornyl isobutyrate	1895	0.20
p-Vinylanisole	1398	0.04	Benzaldehyde	1936	11.35
AR, *α* –Dimethylstyrene	1410	0.07	Jasmone	1974	0.04
Furfural	1426	0.04	Aromandendrene	2031	0.04
Camphenone	1435	0.07	1H-Benzocycloheptene	2038	0.05
α –Copaene	1474	0.11	2-Methoxy-4-vinylphenol	2135	0.18
β –Cubebene	1550	0.04	Carvacrol	2163	0.03
Trans-Ocimene	1525	0.05	Dehydroaromadendrene	2217	0,42
Safranal	1528	0.23	Benzenemethanol	2223	0.07
3-Carene	1534	0.04	Tricosane	2316	0.08

Chrysanthenyl Acetate	1538	0.97	4-venylphenol	2314	0.04
Bornyl acetate	1548	3.00	Hexadecanoic acid	2845	0.09
Safranal	1557	0.33	Osthole	3202	1.19
Caryophyllene	1572	8.18	Monoterpene hydrocarbons		58.08
3,4-Dimethilpyridine	1602	0.05	Oxidized monoterpenes		17.29
Iso-Valeric acid	1630	0.57	Sesquiterpene hydrocarbons		11.24
1,4,7,-Cycloundecatriene	1635	0.72	Predominates, and other substances		7.24
1,3,8-p-Menthatriene	1641	0.85	Total		93.85

Table 2

Antibacterial and Antifungal Activity essential oil flowers of *F.ferganensis*, *alterniflora* (mm, ± SD, P≤0.05)

Sample	*Inhibition zone diameter, mm, ± SD, P ≤ 0.05*				
	B.subtilis	*S.aureus*	*P.aeruginosa*	*E.cole*	*C.albicans*
Essential oil	16.06±0.11	14.04±0.12	15.06±0.11	17.13±0.08	20.08±0.10
Positive Control Canamycin (10µg/disk)	12.05±0.12	25.06±0.15	7.06±0.11	9.06±0.14	0±00
Negative control DMSO (10µg/disk)	3±0.10	5.06±0.11	4.06±0.13	0±00	3.06±0.12

Antimicrobial activity of essential oil: The essential oil of *F.ferganensis* was screened for its antibacterial activity by using the disk diffusion method. Selected test strains (*Staphylococcus aureus*-91, *Bacillus subtilis*-5, gram-negative bacteria *Escherichia coli*- 221 Ba. Pseudomonas aeruginosa - 225, microscopic fungi, Candida albicans-247) were grown on nutrient broth medium at 37 ± 2°C 24 h. The cultured test strains were diluted in 20 ml sterilized distilled water. The turbidity level of the strains used for the test was adjusted with a Mc Farland 0.5 standard (0.5 × 108 CFU / ml). Pathogen test bacterial strains were then inoculated on a lawn using a pre-prepared nutrient agar medium (Hi Media Lab. Ltd., Mumbai, India) sterilized L-shaped glass rod. Crud extracts of plants was soaked in 6-8 mm sterile What man 1 paper. The nutrient was then placed in a petri dish containing pathogenic bacterial strains grown in a medium. A antibiotic canamycin was used as a positive control and dimethyl sulfoxide (DMSO) solution was used as a negative control. Petri dishes were kept in a thermostat at a temperature of 37

± 2°C (Memmert Made in Germany Schutzart DIN EN 60529 - IP20) for 18-24 h. At the end of the incubation period, the zones of inhibition around the disks impregnated with extracts were measured and compared with the values of the zone of inhibition of the antibiotic canamycin **(Table 2)**.

Results of the antimicrobial tests showed that *S. aureus, B. subtilis, E. coli,* and *C. albicans* were sensitive to the effects of *F.ferganensis* essential oil. The greatest antibacterial effect was found against *C. albicans* with an inhibition zone diameter of 20.08±0.10 mm.

Conclusions. The chemical composition was determined by GC-MS, and the chemical composition of the main components of the essential oil of *F.ferganensis* flower growing in Kyrgyzstan was studied for the first time stood out as. The results of in vitro screening showed that essential oil flowers of *F.ferganensis* have antimicrobial properties compared to all tested. (*C. albicans* 20.08±0.10 mm) showed a significant effect on Gram-positive bacteria and fungi

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