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COMPREHENSIVE CHEMICAL CHARACTERIZATION OF FERULA MOSCHATA EXTRACTS USING HPTLC, GC-MS, AND NMR SPECTROSCOPY

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Annotation

This study investigates the chemical composition and biological potential of Ferula moschata, a rare medicinal species from the Umbelliferae family. Using solvent chromatographic methods, and biological assays, the plant's bioactive compounds were analyzed. The findings demonstrate the presence of coumarins, terpenes, flavonoids, and essential oil with significant antioxidant and antimicrobial activity. These results highlight the pharmacological relevance of Ferula moschata and suggest that further in vivo and clinical studies are required to validate its therapeutic applications

Keywords

Ferula genus, Ferula moschata, HPTLC, resin, NMR, GC-MC, Umbelliferae, essential oil, extraction.

КОМПЛЕКСНЫЕ ХИМИЧЕСКОЕ ИССЛЕДОВАНИЕ ЭКСТРАКТОВ FERULA MOSCHATA С ИСПОЛЬЗОВАНИЕМ МЕТОДОВ ВЭТСХ ГХ-МС И ЯМР СПЕКТРОСКОПИИ

Аннотация

В данном исследовании изучен химический состав и биологический потенциал Ferula moschata, редкого лекарственного растения из семейства зонтичных (Apiaceae). С применением растворных хроматографических методов и биологических тестов были проанализированы биологически активные соединения растения. Полученные результаты показали наличие кумаринов, терпенов, флавоноидов и эфирного масла, обладающих выраженной антиоксидантной и антимикробной активностью. Эти данные подчеркивают фармакологическую значимость Ferula moschata и указывают на необходимость проведения дальнейших in vivo и клинических исследований для подтверждения её терапевтического применения.

Ключевые слово

род : Ferula, Ferula moschata, ВЭТСХ, смола, ЯМР, ГХ-МС, зонтичные, эфирное масло, экстракция

FERULA MOSCHATA EKSTRAKTLARINING YUSSX, GX-MS VA YAMR SPEKTROSKOPIYA USULLARI YORDAMIDA KOMPLEKS KIMYOVIY TAHLILI

Annotatsiya

Mazkur tadqiqotda soyabonguldoshlar (Apiaceae) oilasiga mansub noyob dorivor o‘simlik Ferula moschataning kimyoviy tarkibi o‘rganildi. Eritma asosidagi xromatografik usullar va biologik tahlillar yordamida o‘simlikning biologik faol moddalari tahlil qilindi . tadqiqot natijalarida kumarinlar, terpenlar, flavonoidlar, efir yog‘lari mavjudligi hamda ularning kuchli antioksidant va antimikrob faoliyatga egaligi aniqlandi. Bu ma’lumotlar Ferula

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moschataning farmakologik ahamiyatini namoyon qiladi va uning terapevtik qo‘llanilishini tasdiqlash uchun qo‘shimcha in vivo va klinik tadqiqotlar o‘tkazish zarurligini ko‘rsatadi.

Kalit so‘zlar

Ferula turkumi, , Ferula moschata, YuSSX, smola, YaMR, GX-MS, Umbelliferae, efir yog‘i, ekstraksiya

Introduction. The genus Ferula, belonging to the family Umbelliferae (Apiaceae), includes more than 170 species distributed across Central Asia, the Middle East, and the Mediterranean basin. Several species of Ferula are highly valued in ethnomedicine due to their antimicrobial, antioxidant, anti-inflammatory, and antispasmodic activities. Among them, Ferula moschata is a relatively rare species traditionally used as a sedative, tonic, and remedy for various ailments. Despite its ethnopharmacological importance, scientific research on Ferula moschata remains limited, especially concerning its phytochemical composition and pharmacological potential. The present study aims to provide a systematic analysis of the phytochemicals of Ferula moschata and to evaluate its antioxidant, antimicrobial, and cytotoxic properties through experimental assays. Ferula moschata is a perennial herbaceous plant that can reach up to 2.5 m in height. The species is hermaphroditic, bearing both male and female organs, and is primarily pollinated by insects. It is also self-fertile. This resinous species is characterized by a cylindrical, hollow, and succulent stem. The leaves are sheathed, pluripinnate, and divided into slender, linear laciniae. The flowers are large, umbellate in shape, and usually yellow, though they may sometimes appear white. Flowering occurs from May to July.

Fig.1. Botanical illustration of Ferula moschata

Material and methods. Roots of Ferula moschata were collected during the flowering season from natural populations in Samarkand. The species was identified by a plant taxonomist, and a voucher specimen was deposited in the Herbarium of the Institute of Botany for future reference. The collected plant material was air-dried, powdered, and subjected to solvent extraction using ethanol, methanol, and aqueous solvents. Soxhlet extraction and maceration methods were applied to maximize phytochemical yield. Extracts were concentrated under reduced pressure and stored at 4°C until analysis. Preliminary phytochemical screening was performed following standard protocols to identify alkaloids, flavonoids, terpenes, coumarins, and essential oils. Chromatographic methods, including Thin Layer Chromatography (TLC), High-Performance Liquid Chromatography (HPLC), and Gas Chromatography–Mass Spectrometry (GC–MS), were used for compound identification and quantification.

Results. The medicinally used part of the plant is the root. No toxicity phenomena or contraindications have been reported, except in cases of individual hypersensitivity. Phytotherapeutic applications of the root include beneficial effects on:

- digestive organs,
- endocrine system,

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- enteric nervous system,
- stomach,
- gastro-enteric tract,
- uterus,
- uterus and ovaries.

In addition to medicinal applications, it should be noted that a gum is extracted from the root, which is traditionally used as a perfume and incense Phytochemical screening revealed the presence of alkaloids, flavonoids, coumarins, terpenes, and essential oils in Ferula sumbul extracts. GC–MS analysis identified sesquiterpene coumarins, monoterpenes, and other volatile compounds as major constituents. Antioxidant assays demonstrated strong radical scavenging activity, with IC50 values comparable to standard antioxidants such as ascorbic acid. Antimicrobial assays showed significant inhibitory effects against Staphylococcus aureus and Candida albicans, while moderate activity was observed against Gram-negative bacteria.

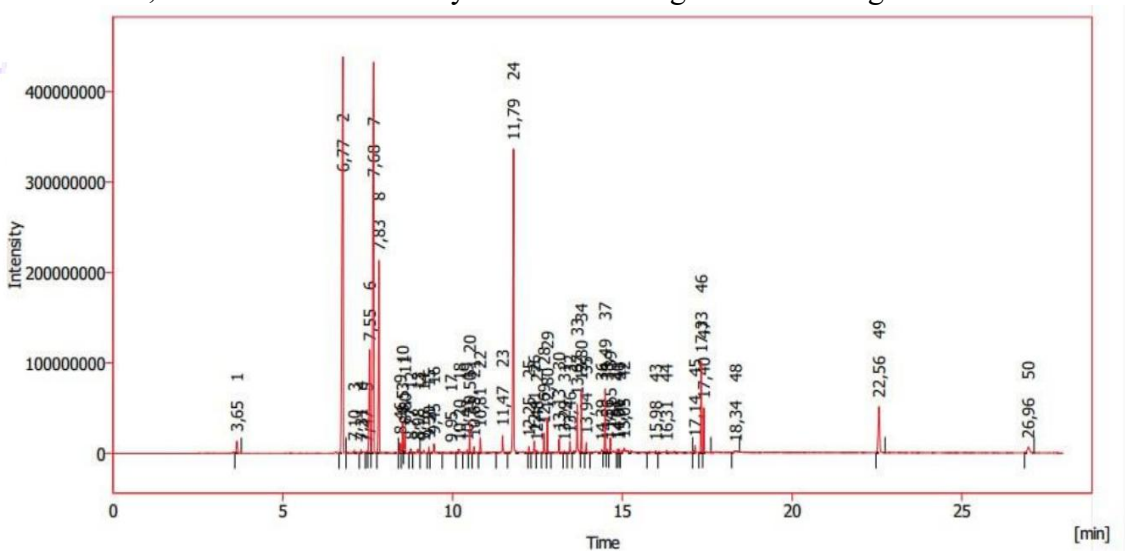

Figure 2. Chromatogram of essential oil isolated from Ferula moschata

Table 1. Ferula Essential Oil GC/MS Results Ferula moschata

№	Compounds	Retention time	%
1.	1 S - - Pinene	6.769	23.36
2.	Camphene	7.102	0.26
3.	Benzene, 1-ethyl-3-methyl-	7.306	0.20
4.	1,3-Cyclohexadiene, 1,3,5,5-tetramethyl	7.475	0.09
5.	Cis-sabinene	7.554	5.23
6.	β- Pinene	7.676	20.60
7.	-Myrcene	7.83	7.67
8.	o- Cymol	8.457	0.33
9.	Limonene	8.528	1.84
10.	trans - Ocimene	8.6	0.86
11.	p- cis - Ocimene	8.768	0.13
12.	-Terpinene	8.976	0.18
13.	2-Heptenoic acid, 3-methyl-, methyl ester	9.155	0.11
14.	Fenchone	9.302	0.17
15.	-Campholenal	9.453	0.46
16.	1-Oxaspiro[2.5] octane , 2,4,4-trimethyl-8-	9.954	0.16

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	methylene-		
17.	Pinocarvone	10.202	0.25
18.	(3E,5Z)-1,3,5-Undecatriene	10.428	0.17
19.	Terpinen-4-ol	10.503	0.77
20.	Benzaldehyde , 4-methoxy	10.632	0.28
21.	Anethole	10.811	0.84
22.	2-Dodecanone	11.474	0.75
23.	(E) Longipinene	11.793	12.48
24.	-Copaene	12.248	0.19
25.	Germacrene D	12.406	0.41
26.	Caryophyllene	12.481	0.14
27.	Humulene	12.692	0.60
28.	γ- Elemene	13.333	0.55
29.	trans-Cadina-1(6),4-diene	13.291	0.11
30.	7-Oxabicyclo[4.1.0]heptane, 1-(1,3-dimethyl-1,3-butadienyl)-2,2,6-trimethyl-, (E)-	13.459	0.43

Conclusion. Ferula moschata is a promising medicinal plant containing diverse bioactive compounds, including coumarins, terpenes, and flavonoids. Its strong antioxidant and antimicrobial properties, combined with observed cytotoxicity, underline its potential for pharmaceutical applications. Further investigations are required to isolate pure compounds, study their mechanisms of action, and evaluate safety through preclinical and clinical studies.

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