Chromatography-mass spectrometric study of Arceuthobium oxicedri raw material

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of the article

Arceuthobium oxycedri, M. Bieb., commonly known as dwarf mistletoe, is widespread in the Mediterranean region, parasitizing the branches of *Juniperus oxycedrus* as a host plant. Compared to white mistletoe, it is more aggressive. It exhibits antibacterial, antifungal, phytotoxic, cytotoxic, and insecticidal activities.

Aim. The study aimed to investigate the qualitative and quantitative composition of biologically active substances and the biological activity of the methanol extract of juniper dwarf mistletoe (*Arceuthobium oxicedri*, M. Bieb.) as a potential source of medicinal substances.

Materials and methods. The object of the study was the shoots and branches of juniper dwarf mistletoe collected during the fruiting phase. The qualitative and quantitative determination of components was carried out at the Department of Toxicological and Inorganic Chemistry, Zaporizhzhia State Medical and Pharmaceutical University.

Results. Chromatography-mass spectrometric analysis of juniper dwarf mistletoe identified 34 components, the main ones being γ-curcumin (20.405 %), cedrol (17.619 %), epimanoyl oxide (5.142 %), and humulene (3.893 %).

Conclusions. The data obtained indicate the significant value of juniper dwarf mistletoe as a source of biologically active compounds, providing a basis for further study to develop promising medicinal substances.

Keywords: juniper dwarf mistletoe, gas chromatography-mass spectrometry, plant extract, qualitative composition, quantitative composition.

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Хромато-мас-спектрометричне дослідження сировини Arceuthobium oxicedri

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Arceuthobium oxycedri, M. Bieb., або омела карликова поширена в Середземноморському регіоні і живе на гілках *Juniperus oxycedrus* – рослині-господарі. Омела карликова є більш агресивною порівняно з омелою білою. Характеризується антибактеріальною, протигрибковою, фітотоксичною, цитотоксичною та інсектицидною діями.

Мета роботи – дослідження якісного та кількісного складу біологічно активних речовин і біологічної активності метанольного екстракту арцеутобіума ялівцевого (*Arceuthobium oxicedri*, M. Bieb.) як потенційного джерела лікарських засобів.

Матеріали і методи. Об'єкт дослідження – омели карликової пагони та гілки, зібрані у фазу плодоношення. Дослідження якісного складу та кількісне визначення компонентів здійснили на кафедрі токсикологічної та неорганічної хімії Запорізького державного медико-фармацевтичного університету.

Результати. У результаті хромато-мас-спектрометричного дослідження арцеутобіума ялівцевого ідентифіковано 34 компоненти, основні з них – γ-куркумін (20,405 %), кедрол (17,619 %), епіманоїлоксид (5,142 %), гумулен (3,893 %).

Висновки. Результати дослідження дали підстави зробити висновок, що арцеутобіум ялівцевий має особливу цінність як джерело біологічно активних сполук, а отже доцільно продовжити його вивчення для розроблення перспективних лікарських засобів.

Ключові слова: арцеутобіум ялівцевий, хромато-мас-спектрометричне дослідження, рослинний екстракт, якісний склад, кількісний склад.

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Expanding the arsenal of official medicinal plants and developing phytopreparations with diverse pharmacological effects based on them is a pressing issue in modern pharmacy.

In recent years, the demand for original phytopreparations has increased, explaining the growing interest in juniper dwarf mistletoe as a potential source of biologically active compounds.

The species currently under investigation is *Arceuthobium oxycedri*, M. Bieb., or dwarf mistletoe, a plant widespread in the Mediterranean region. It parasitizes the branches of juniper, larch, and cypress as a host plant. The genus is related to Viscum, but it is distinguished by the fact that its anthers differ from the petals and do not adhere to them along their entire length or most of it.

Arceuthobium oxicedri (juniper dwarf mistletoe) is a semiparasitic plant found across the Carpathian region, as well as in Crimea, the Caucasus, Central Asia, the Mediterranean, Central Europe, the Balkan Peninsula, Asia Minor, Armenia, Iran, Africa, and North and South America. It parasitizes juniper at altitudes of up to 2,000–2,500 meters above sea level [1,2].

Research on the distribution of *Arceuthobium oxycedri* in the Carpathians highlights its dependence on host plants and unique local ecological conditions. This is also supported by the analysis of the distribution of other endemic Carpathian species, particularly in the context of their response to climate change and landscape fragmentation.

Arceuthobium oxycedri is a herbaceous plant of the sandalwood family (*Viscaceae*), with a height ranging from two to twenty centimeters. Its branches are compressed, jointed, and evergreen. The plant is glabrous, with small, scaly leaves arranged in pairs and fused into small sheaths. Flowers are solitary in the leaf axils, unisexual, and dioecious; staminate flowers have a 2–5-lobed perianth, while pistillate flowers have a two-lobed perianth. The small, highly branched parasitic branches are woody [3].

This plant is classified as a hemiparasite due to its ability to photosynthesize. It is a specialized parasite, as it primarily infects plants of the family *Cupressaceae*. *Arceuthobium oxicedri* parasitizes juniper species, particularly *Juniperus oxycedrus* and *Juniperus communis*. In Crimea, this species has been documented parasitizing 20 species and forms of plants from the genera *Cupressus*, *Platycladus*, and *Juniperus*, typically affecting the trunks rather than the shoots. With severe development over 5–10 years, it can cause the death of mature host plants.

The plant contains saponins, alkaloids (0.7 %), flavonoids (myricetin, quercetin), leucoanthocyanins, and anthocyanins (delphinidin, cyanidin). Catechin and myricetin 3-O-glucoside have been identified in its leaves, while the fruits contain essential oils and higher fatty acids (linoleic and linolenic acids, 8–15 %) [4,5].

Studies of the ethyl acetate extract from *Arceuthobium vaginatum* have revealed the presence of polyphenols, glycosylated flavanones, quercetin-glucoside, cinnamates, coumarin, derivatives of cinnamic acid, ferulic acid, coumarate, naringenin, protocatechuic acid, and naringin [6]. Reports also indicate the detection of chlorogenic acid and shatekin in *A. oxycedri* [7].

According to a study by N. Y. Khan et al., gas chromatography-mass spectrometry analysis of the n-hexane fraction identified 21 compounds, including aromatic hydrocarbons, alcohols, tricyclic sesquiterpenes, palmitic and phthalic acids, phytol, and others [5].

The research focused on the chemical composition and biological activity of the methanol extract of *A. oxycedri*. The extract was tested for antibacterial, antifungal, phytotoxic, cytotoxic, and insecticidal activities. Antibacterial and antifungal activities were assessed against ten bacterial and ten fungal strains using agar diffusion and disk diffusion methods. The extract demonstrated high efficacy against three bacteria: *Pseudomonas aeruginosa*, *Escherichia coli*, *Bacillus subtilis*, and the fungus *Candida albicans*. Phytotoxic effects indicated extreme toxicity to *Lemna acquinoctialis*. The extract exhibited significant cytotoxicity against brine shrimp at all tested concentrations and notable cytotoxicity against *Candida albicans* in flow cytometry assays [8].

The stems and leaves of *Arceuthobium oxicedri* have been widely used in traditional medicine as antitumor, antioxidant, anti-inflammatory, anticholinesterase, and anticonvulsant agents [4,7,8].

Studies suggest that the n-hexane extract of *A. oxycedri* could serve as an alternative anticancer agent in the future, with fewer side effects than other mistletoe species currently used in cancer treatment in European countries [5].

In Turkish traditional medicine, the plant is considered a panacea for various ailments, including infectious and inflammatory diseases of the upper respiratory tract and gastrointestinal system, as well as a hypotensive agent [9].

A detailed analysis of scientific literature revealed a lack of comprehensive studies on the chemical composition and pharmacological activity of *Arceuthobium oxicedri*. Therefore, further research on this plant is highly relevant.

Aim

The study aimed to investigate the qualitative and quantitative composition of biologically active substances and the biological activity of the methanol extract of juniper dwarf mistletoe (*Arceuthobium oxicedri*, M. Bieb.) as a potential source of medicinal substances.

Materials and methods

The object of the study was the shoots and branches of *Arceuthobium oxycedri*, collected during the fruiting phase, which served as a source for obtaining a methanol extract. The methanol extract was stored at room temperature.

Qualitative and quantitative analyses of the components were conducted at the Department of Toxicological and Inorganic Chemistry, Zaporizhzhia State Medical and Pharmaceutical University (headed by O. I. Panasenko, PhD, DSc) using an Agilent Technologies 6890 chromatograph with a 5973 mass spectrometer detector. Analysis conditions:

chromatographic column – Capillary DB-5; column length – 30 m; internal diameter – 0.25 mm; carrier gas – helium; carrier gas flow rate – 1 mL/min; sample volume – 0.1–0.5 µL; thermostat temperature – programmed from 50 °C to 220 °C; detector and evaporator temperature – 250 °C.

Components were identified by comparing the obtained mass spectra of the chemical compounds in *Arceuthobium oxicedri* with data from the NIST05 and WILEY 2007 mass spectrum libraries, containing over 470,000 spectra. Identification software AMIDIS and NIST were used.

Results

The gas chromatography-mass spectrometry analysis of biologically active compounds of *Arceuthobium oxycedri* identified 34 components *(Table 1, Fig. 1)*, including 2 monoterpenes, 1 monoterpene alcohol, 15 sesquiterpenes, 2 triterpenes, 3 terpene esters, 1 terpene oxide, 6 aliphatic hydrocarbons, 1 aldehyde, 1 ketone, and 1 amide.

The most abundant compounds were γ-curcumene (20.405 %), cedrol (17.619 %), pi-mannoxy oxide (5.142 %), and humulene (3.893 %).

Table 1. Qualitative and quantitative content of biologically active compounds of *Arceuthobium oxycedri*

No.	Retention time	Components	Content, %	Class of compounds
1	16.24	Terpinen-4-ol	0.454	Monoterpene alcohol
2	22.95	β-Cubebene	0.358	Monoterpene
3	23.12	Thujopsene	0.234	Sesquiterpene
4	23.50	β-Elemene	0.991	Sesquiterpene
5	23.55	Humulene	3.893	Sesquiterpene
6	23.86	γ-Curcumene	20.405	Sesquiterpene
7	24.01	Germacrene D	1.130	Sesquiterpene
8	24.16	Zingiberene	0.192	Monoterpene
9	24.27	α-Farnesene	0.181	Sesquiterpene
10	24.63	δ-Cadinene	0.351	Sesquiterpene
11	25.07	Cedrene	0.192	Sesquiterpene
12	25.13	Elemol	0.540	Sesquiterpene
13	25.26	Nerolidol	0.488	Sesquiterpene
14	25.78	Caryophyllene oxide	0.427	Sesquiterpene
15	26.06	Spathulenol	1.185	Sesquiterpene
16	26.28	Cedrol	17.619	Sesquiterpene
17	27.76	Valerenal	0.555	Aldehyde
18	28.54	Valeranone	1.082	Ketone
19	29.38	Hexahydrofarnesyl acetate	1.098	Terpene ester
20	30.64	Biformene	2.608	Amide
21	30.76	Myrtenyl acetate	0.507	Terpene ester
22	31.31	Sandaracopimaradiene	1.144	Triterpene
23	31.65	Pi-mannoxy oxide	5.142	Terpene oxide
24	31.74	Isopimaradiene	0.603	Sesquiterpene
25	32.35	Dehydroabietane	1.225	Triterpene
26	32.61	Heneicosane	0.674	Aliphatic hydrocarbon
27	32.78	Cedryl acetate	1.130	Terpene ester
28	32.92	β-Caryophyllene	2.944	Sesquiterpene
29	34.86	Tricosane	1.855	Aliphatic hydrocarbon
30	35.92	Tetracosane	0.823	Aliphatic hydrocarbon
31	36.93	Pentacosane	2.262	Aliphatic hydrocarbon
32	37.27	Docosane	0.974	Aliphatic hydrocarbon
33	37.91	Hexacosane	0.722	Aliphatic hydrocarbon

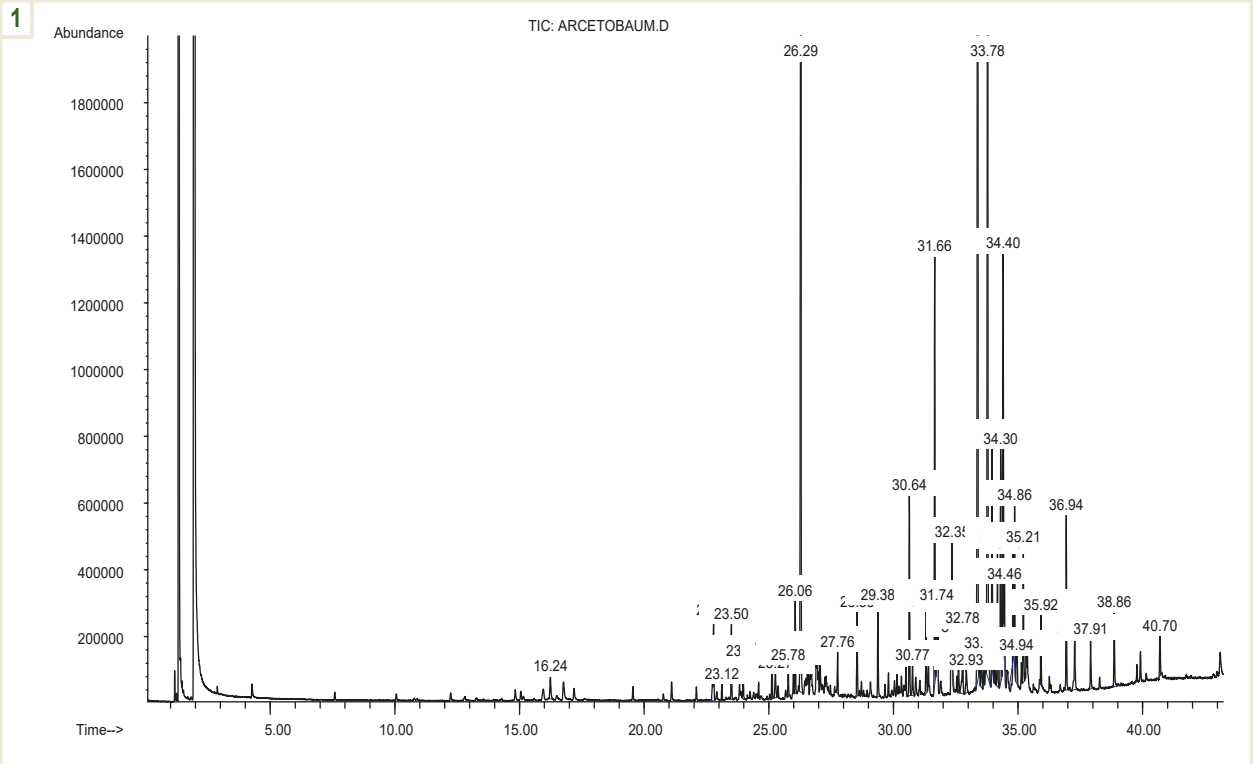

Fig. 1. Chromatogram of biologically active compounds of *Arceuthobium oxycedri*.

Discussion

A review of the literature showed that curcumene exhibits anti-inflammatory properties for the treatment of chronic inflammatory diseases and antitumor activity in the therapy of certain cancers. Curcumene effectively alleviates chemotherapy-induced hepatotoxicity [8,10,11,12].

Cedrol possesses cardioprotective, sedative, tonic, bactericidal, antiviral, antiseptic, anti-inflammatory, immunomodulatory, antioxidant, antiallergic, spasmolytic, and insecticidal effects.

Studies of humulene confirm its antitumor activity against malignant tumor growth. Humulene is also an antibacterial agent effective against *Staphylococcus aureus* and in treating skin diseases, gastrointestinal infections, and respiratory infections [13,14].

Conclusions

1. The gas chromatography-mass spectrometry analysis of *Arceuthobium oxycedri* identified 34 components, with the major ones being γ-curcumene (20.405 %), cedrol (17.619 %), pi-mannoxy oxide (5.142 %), and humulene (3.893 %).

2. The obtained data indicate the exceptional value of *Arceuthobium oxycedri* as a source of biologically active compounds, warranting further research to develop promising medicinal products.

3. Considering the biological properties of the main active compounds, the raw material of *Arceuthobium oxycedri* can be recommended for further pharmacological screening for antioxidant, antimicrobial, and anti-inflammatory activity.

Conflicts of interest: authors have no conflict of interest to declare.
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