

STUDY OF BIOLOGICALLY ACTIVE
SUBSTANCES OF THE *LECOKIA CRETICA* DC.
FROM THE FAMILY *APIACEAE* LINDL.
ВИВЧЕННЯ БІОЛОГІЧНО АКТИВНИХ
РЕЧОВИН *LECOKIA CRETICA* DC. З РОДИНИ
APIACEAE LINDL.

Sayyara Ibadullayeva¹, Adely Aleskerova¹,
Aydan Husuyeva¹, Hilal Imanli¹, Elvin Kerimli^{1,2},
Emil Shukurlu¹, Elshan Akhmedov³,
Oleksandr Maslov³, Alla Koval³

¹Institute of Botany, Ministry of Science and
Education of the Republic of Azerbaijan, Baku,
Azerbaijan

²Azerbaijan Medical University, Department of
Pharmacognosy, Baku, Azerbaijan

³National University of Pharmacy, Kharkiv, Ukraine

Introduction. *Lecokia* is a monotypic genus of flowering plants belonging to the family *Apiaceae*. It just contains one species, *Lecokia cretica* (Lam.) DC [1]. Its homeland is Cyprus, The Eastern Aegean Islands, Palestine, Southern Caucasus-Azerbaijan, Syria, and Turkey [21].

The article is devoted to the extraction of biologically active substances from *Lecekia cretica* (Lam.) D.C., investigation of its chemical composition and the properties of sesquiterpene lactones and coumarins and identification with other substances obtained from other species of the family.

Furocoumarin preparations are meladin, melexan, amifurin, and psoralen. From terpenoids - sesquiterpene lactones have anthelmintic, cardiotonic, anti-inflammatory, against thermal, chemical and radiation burns, healing trophic wounds, antimicrobial, bactericidal, antitumor, antiprotozoal, antifeedant properties. Steroids, on the other hand, regulate growth in plants and have other activities. [1, 2, 3, 8, 9, 15, 16, 20].

Biologically active substances obtained from species belonging to the *Apiaceae* Lindl. family distributed in the flora of Azerbaijan are used in the prevention and treatment of many diseases such as oncological, nervous, cardiovascular system deficiency. In this regard, sesquiterpene lactones, furocoumarins, and isocoumarins are among the biologically active substances obtained from the plant species belonging to this family, which are mainly used as antioxidant, anticarcinogenic, antimutagenic, and immune system enhancing agents. Using the column chromatography method, the following coumarin derivatives were identified from the sum of extractive substances obtained from the species of the family *Apiaceae* Lindl. with known substances.

Lecokia cretica (Lam.) D. C., which is the studied plant species belongs to the family *Apiaceae* Lindl. The species that characterize the representatives of this family are rich in coumarin derivatives. The study of biologically active substances of plant origin and the role of coumarin derivatives in the plants is still not clear enough. However, substances obtained from them are widely used in medical practice, experimental research, etc. Some of them are growth inhibitors, others affect seed

germination, and sometimes coumarin derivatives act as plant protectors.

Species of the family *Apiaceae* Lindl. are characterized by the presence of coumarin derivatives, sesquiterpene lactones, sesquiterpenoid coumarin derivatives, aromatic compound esters, and etc.

Lecokia is a monotypic genus of flowering plants belonging to the family *Apiaceae*. It just contains one species, *Lecokia cretica* (Lam.) DC. [21].

The chemical composition of this species belonging to the family *Apiaceae* Lindl. was studied by us for the first time in Azerbaijan. The family *Umbelliferae* includes about 300 genera and about 3000 species.

Data from the global literature indicates that around 1626 plant species, belonging to 568 genera and 134 families, have been identified to contain coumarin derivatives [5].

Additionally, there is enough proof that sesquiterpene lactones and coumarin derivatives have anticancer properties. Quinic acid, chlorogenic acid and aliphatic acid (malic acid) were obtained from the ethanolic extract of *Lecokia cretica* species [9,10,11,16].

Based on data from the literature, the Turkish researchers like Aras. A., Bursal, E., Turkan, F., Tohma, H., Kilich, O. Gulchin, I., & Koksall, E. have identified 2 new sesquiterpene glycosides: 1 α ,6 β ,9 β - trihydroxy – eudesm -4 (15)-ene-1,6-O- β -diclopyranoside (1), 1 α ,6 β ,9 β -trihydroxy-eudesm-3-ene-1,6-O- β -diglycopyranoside (2). In addition, from the whole parts of *Lecokia cretica* 1 α , 6 β ,9 β -trihydroxy-5,10-bis-epi-eudesm-3-ene- 6-O- β -glycopyranoside (3) chlorogenic acid (4), luteolin 7-O-rutinoside (5) and luteolin 7-O-glucoside (6) were obtained. Their structures were identified based on 1D, 2D NMR and HRMS analyses. *In vitro* cytotoxic activity of 1-3 compounds against human lung cancer cells (A549) and human lung cells (BEAS-2B) was determined using MTT assay. All tested eudesmane sesquiterpene lactone derivatives were found to be inactive [19].

Taban Akcha, K. Gurbuz, P. Dogan, Sh. D., Emerce, E. Goren, A. C. Polat, R., & Suntar I. have investigated the phytochemical composition, antidiabetic, anticholinergic and antioxidant properties of *Lecokia cretica* extracts. Acetylcholinesterase (AChE), butyrylcholinesterase (BChE) and α -glycosidase enzymes were strongly inhibited by *Lecokia cretica* extracts. The C₅₀ values of the three enzymes were determined to be 3.21 mg/mL, 2.1 mg/mL, and 2.07 mg/mL, respectively. Antioxidant activity was investigated in both aqueous and ethanolic (EtOH) extracts using CUPRAC, FRAP and DPPH methods. Moreover, phenolic compounds of the endemic plant were identified and quantified by HPLC/MS/MS method. Based on the results, it was confirmed that the extracts have antioxidant activity. Quinic acid (12.76 mg/kg of crude extract), chlorogenic acid (3.39 mg/kg), and malic acid (2.38 mg/kg), were the most abundant phenolic acids of *Lecokia cretica* in EtOH extract [21].

Plant-derived coumarins indeed exhibit a wide range of properties that make them significant in practical medicine which include analgesic, capillary strengthening, antiarrhythmic, coronary dilation, and pressor effects, among others.

It is known that a coumarin peucedanine has an activity against malignant tumors. Other coumarin derivatives, bergapten, "Pastinacin" medicine, which consists of a mixture of sfondine and xanthotoxin acts as a painkiller, "Beroxan" medicine consisting of a mixture of bergapten and xanthotoxin, "Ammifurin" consisting of a mixture of isopimpinellin and bergapten, "Psoralen" consisting of a mixture of psoralen and angelicin, "melodin" containing xanthotoxin and imperatorin are medicines used in the treatment of vitiligo. [1, 2, 3, 7, 9].

Ammifurin, psoralen, berexan, melodanin, methoxalen, etc. which are prepared based on the furocoumarins (bergapten, xanthotoxin and psoralen) are widely used in the treatment of leukoderma worldwide [1, 2, 3].

Therefore, their chemical and pharmacological properties attract increasing interest from researchers.

Materials and methods

Lecokia cretica is the only representative of the *Lecokia* genus found in Azerbaijan. Only one species, *Lecokia cretica* belongs to this genus. Morphological properties: the trunk is straight, furrowed and branched from above, with 30-50 cm height. Fruits are oval, 10-15 mm long. Blooms and bears fruits in May-June. Distribution area: Lankaran mountains, Republic of Azerbaijan. In the middle mountain belt - In shady forests. It is a perennial, bare plant. Only one species, *Lecokia cretica* belongs to the genus [14].

Flowers are bisexual, sometimes unisexual, monoecious, rarely dioecious, generally found in compound umbels, rarely found in simple or hypanthodium. In the lower part of the umbels, there is usually a curtain consisting of several leaves (sometimes 1-2 leaves that fall quickly), and in the lower part of the umbels, there are sepals. Sepals might be present or absent. Petals are usually tiny, 5 pieces, white, pink, yellow, greenish, with 5 stamens. Inferior ovary, two-parted, subcolumnar at the apex (stylopodium, glandular disk), and two columnar; the lower column is usually conical or cushion-shaped, sometimes flat, ring-shaped or cuboidal. The fruit is dry, divided longitudinally into two one-seeded mericarps.

Lecokia cretica is a perennial glabrous plant. Only one species, *L. cretica* belongs to *Lecokia* genus [22]. *Lecokia* is a monotypic genus of flowering plants belonging to the family *Apiaceae*. It just contains one species, *Lecokia cretica* (Lam.) DC.

Distribution:.. Caucasus. (Talysh). Worldwide distribution: Balkans.-Malaysia. (Asia Minor), Iran. (northern). In Azerbaijan, it is common in Lankaran Mountains, middle-mountainous area, in shady forests. Plant material was harvested at the beginning of the flowering phase from the Hirkan reserve area of Lankaran. After the material was chopped into small pieces and dried appropriately, using a known method, 535 g of raw materials were extracted with acetone (3 times for three days each), and the total extractive components were used (35.0 g, yield 6.4%). The total extractive components (15.0 g.) were chromatographed in a glass column (H=70 cm, D=3.5 cm) filled with neutral Al_2O_3 (activity grade III-IV), and 7 different component substances and 6

coumarin derivatives from the aerial part were individually isolated.



Fig. 1. Herbarium of *Lecokia cretica* species and its photo in nature

In column chromatography, the dry extract was fractionated with the following solvents: with hexane - 8 fractions, with hexane + benzene 1:3 - 5 fractions, with pure benzene-6 fractions, mixture of benzene+chloroform

(9:1;8:1;7:1;6:1;5:1;4:1;3:1;2:1;1:1), with a mixture of chloroform and alcohol 99:1; 98:2; 97:3. The volume of each fraction is 100 ml. A dark colored extract was obtained from 8 fractions in the ratio of hexane-benzene (1:1), 13,14,15,16,17,18,19 and etc. fractions in the ratio of hexane-benzene (1:2). Starting from fraction 26, hexane+benzene (1:3), starting from fraction 34, hexane+benzene (1:4) were used. Crystals were obtained from fractions 26-29. Crystals are obtained in an aqueous alcoholic medium. Starting with fraction 50, column chromatography was eluted with hexane + benzene (1:4). Starting from fraction 86, column chromatography was eluted with pure benzene, starting from fractions 91-103, eluted with hexane + benzene + chloroform (1:1:1) and a crystalline substance was obtained, and the individual substance was obtained by combining them and recrystallizing in aqueous ethanol. Starting at fraction 130, the column was eluted with a mixture of hexane + benzene chloroform (1:1:3). To obtain individual substances from the obtained mixed crystalline substances, column chromatography was performed using aluminum oxide as a stationary phase. Then fractions 1 and 2 were obtained with benzene, and fractions 3, 4, 5 with chloroform. Individual substances were obtained from these obtained fractions.

Studies on the total extractive substances obtained from the herb of *Lecokia cretica* plant were conducted in two directions. Using the first method with column chromatography, *Lecokia cretica* root was eluted with benzene+chloroform (1:2). From fraction 78-80, individual crystalline substance was obtained in aqueous alcohol (first substance), (second substance), from fractions 81-83 were eluted with benzene+chloroform (1:3) and the individual substance was crystallized in aqueous alcohol. The third substance was eluted with benzene and fraction 48 was crystallized in aqueous alcohol (the third individual substance). The fourth substance was obtained with chloroform + hexane (4:1), the substance was crystallized in alcohol after two fractions. The individual substance was obtained from fraction 56 (the fourth substance). The fifth substance: from fractions 66-67, the individual substance was obtained with chloroform + benzene (1:1) and crystallized in aqueous alcohol. The sixth substance was eluted with benzene + chloroform, the individual substance was obtained from fraction 57-58 (1:1) and crystallized in aqueous alcohol (the sixth substance). The individuality of the substances was determined by thin-layer chromatography on silufol UV-254 plates, and the melting

temperatures of the crystalline substances according to the Boyites table.

Various components and coumarins were obtained from the total extractives obtained by extracting the roots of the *Lecokia cretica* plant with acetone. Names of substances identified as a result of GC-MS analysis: 1.methoxaline, 2.bergapten, 4.pimpinellin, 5.isopsarelin 6. methoxsalen

Conditions of gas-chromatography mass-spectrometry: For the analysis, GC-MS (Shimadzu QP-2010 Ultra GC-MS, Japan) was used. Electronic ionization, capillary tube Rtx – 5 MS with dimensions of 0.25 μm $\times$ 0.25 mm $\times$ 30 m. Helium gas is used as the mobile phase at a flow rate of 1.58 mL/min.

The temperature of the ionization source was 250°C. During the analysis, the starting temperature of the thermostat was 40°C for 2 minutes stable, then increased to 200°C at 9°C/min speed, and afterwards increased to 250°C at 10°C/min speed. 17 minutes were spent on the analysis of each sample. The temperature of the injector is 275°C. The amount of taken samples was 0.2 μL (diluted with chloroform 1:20). The electron ionization of the mass detector is 70 and the mass range was chosen as 29-450 a.m.u. (atomic mass unit, Da). After analysis, the substances were identified based on the data of the device (NIST 2010), the retention time - t_R (Retention time), characteristic molecular and fragment ions.

Results and Discussion

The herb of the *Lecokia cretica* plant, which is the main object of the study, were studied in two directions. Firstly, the column chromatography method, and secondly, the gas chromatography-mass spectroscopy method were used. As a result of analysis, coumarin derivatives, sesquiterpene lactones and acids were determined in the sum of extractive substances obtained by acetone extraction of the aerial parts of *Cretica* species.

Samples of the herb of *Lecokia* were analyzed by GS-MS method and the results of the chemical composition are given in table No 1. Malic acid, eudesmanolide sesquiterpene lactone and coumarin derivatives were obtained from the aerial parts of *Lecokia cretica*.

As a result of the chromatographic analysis of *Lecokia cretica* plant samples, 14 compounds with different molecular masses and chemical structures were identified.

Table 1. The lists of the component names, retention times, formulas, and molecular masses.

№	Name	Retention time	Formula	M, g/mol
1	D-Alanine, N-ethoxycarbonyl-, ethyl ester	4.07	$\text{C}_8\text{H}_{15}\text{NO}_4$	189.21
2	Butanoic acid, 2,3-dichloro-, methyl ester	5.13	$\text{C}_5\text{H}_8\text{Cl}_2\text{O}_2$	171.02
3	2,4,6-Trimethoxystyrene	11.46	$\text{C}_{11}\text{H}_{14}\text{O}_3$	194.23
4	Hexadecanoic acid, methyl ester	14.02	$\text{C}_{17}\text{H}_{34}\text{O}_2$	270.5
5	α -Santonin	19.31	$\text{C}_{15}\text{H}_{18}\text{O}_3$	246.30
6	Hexadecanoic acid 2-hydroxy-1-(hydroxymethyl) ethyl ester	22.58	$\text{C}_{19}\text{H}_{38}\text{O}_4$	330.5
7	Diisooctyl phthalate	23.16	$\text{C}_{24}\text{H}_{38}\text{O}_4$	390.6
8	Bergapten	16.04	$\text{C}_{12}\text{H}_8\text{O}_4$	216.19

№	Name	Retention time	Formula	M, g/mol
9	7H-Furo[3,2-g] [1] benzopyran-7-one, 9-methoxy-	11.15	C ₁₂ H ₈ O ₄	216.0
10	Pimpinellin	17.60	C ₁₃ H ₁₀ O ₅	246.21
11	2-Propenoic acid, 3-(4-hydroxy-3-methoxyphenyl)	17.60	C ₁₀ H ₁₀ O ₄	194.18
12	Isopsoralen	16.04	C ₁₁ H ₆ O ₃	186.16
13	Angelecic	11.15	C ₁₁ H ₆ O ₃	186.16
14	Methoxsalen	11.15.	C ₁₂ H ₈ O ₄	216.19

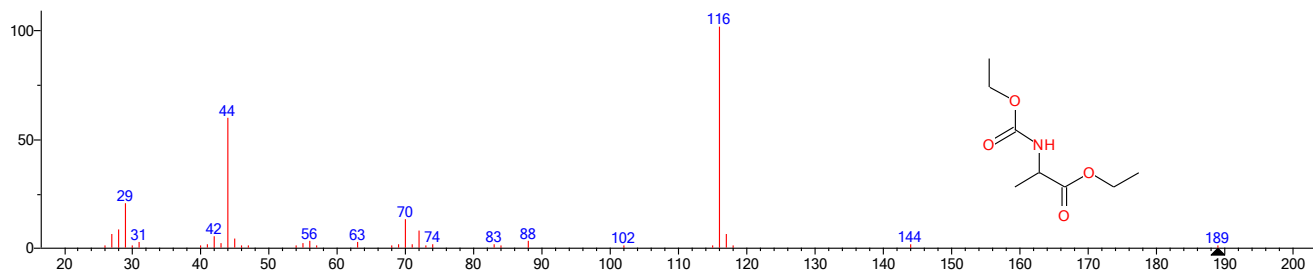


Fig. 2. D-Alanine, N-ethoxycarbonyl-, ethyl ester, C₈H₁₅NO₄ (1)

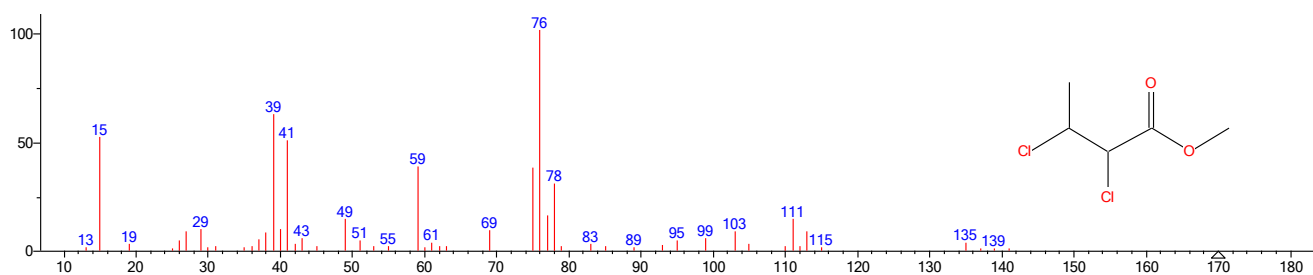


Fig. 3. Butanoic acid, 2,3-dichloro-, methyl ester C₅H₈Cl₂O₂ (2)

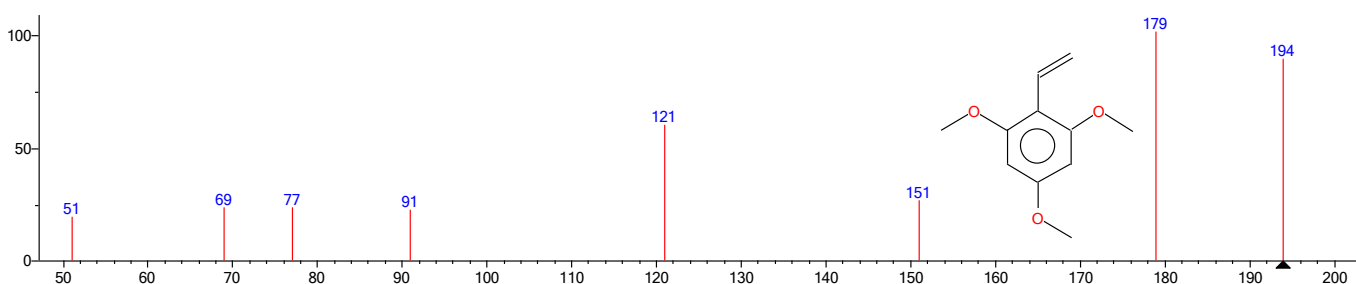


Fig. 4. 2,4,6-Trimethoxystyrene C₁₇H₃₄O₃ (3)

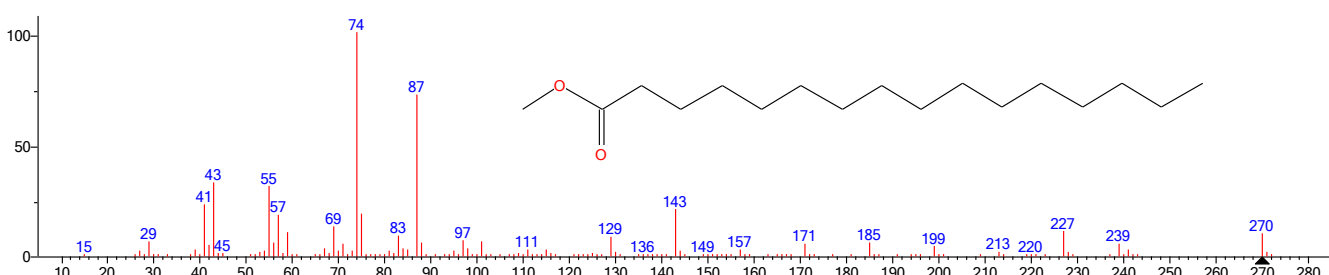


Fig. 5. Hexadecanoic acid, methyl ester C₁₇H₃₄O₂ (4)

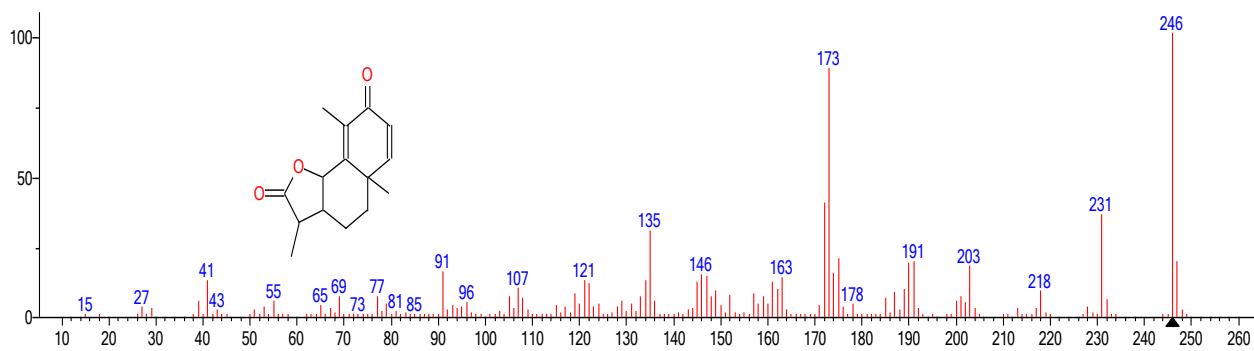


Fig. 6.

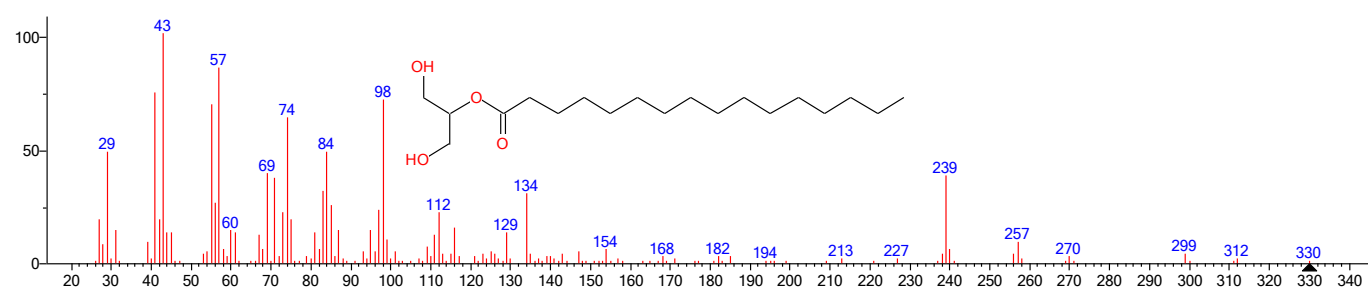


Fig. 7. Hexadecanoic acid 2-hydroxy-1-(hydroxymethyl) ethyl ester $C_{19}H_{38}O_4$ (6)

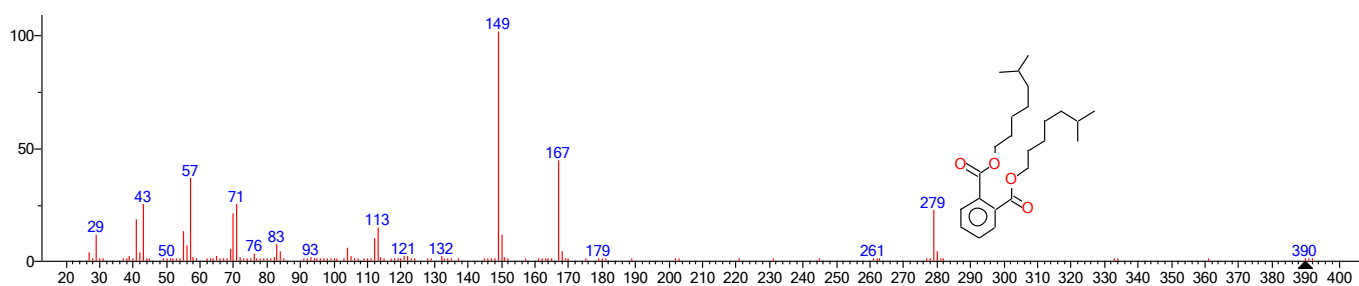


Fig. 8. Diisooctyl phthalate $C_{24}H_{38}O_4$ (7)

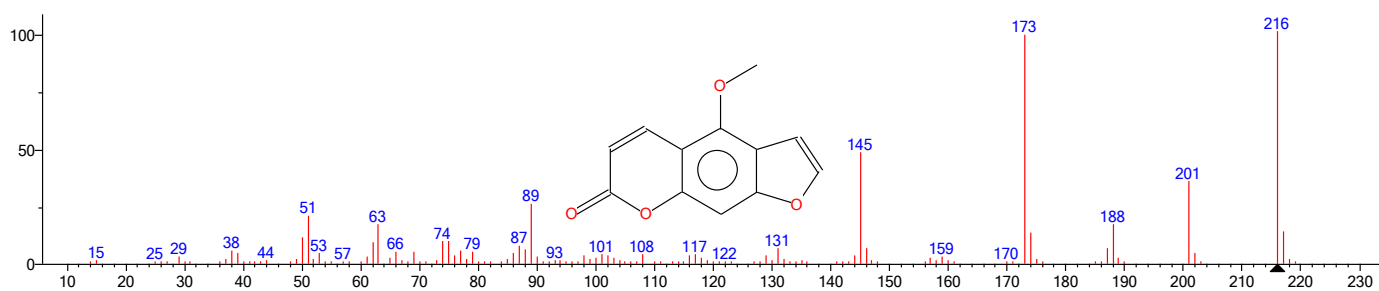


Fig. 9. 7H-Furo[3,2-g][1] benzopyran-7-one, 9-methoxy- $C_{12}H_8O_4$ (8)

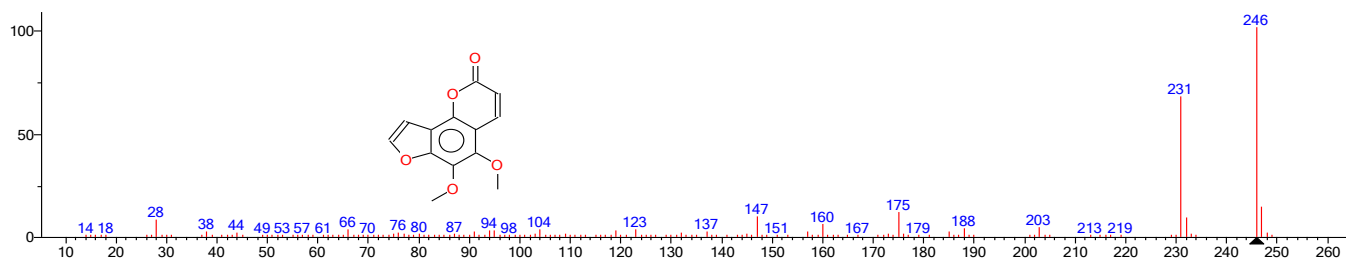


Fig. 10. Pimpinellin $C_{13}H_{10}O_5$ (10)

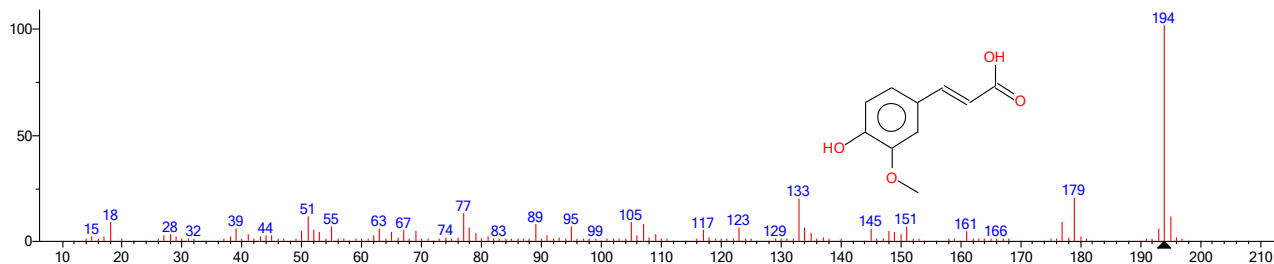


Fig. 11. 2-Propenoic acid, 3-(4-hydroxy-3-methoxyphenyl) $C_{10}H_{10}O_4$ (11)

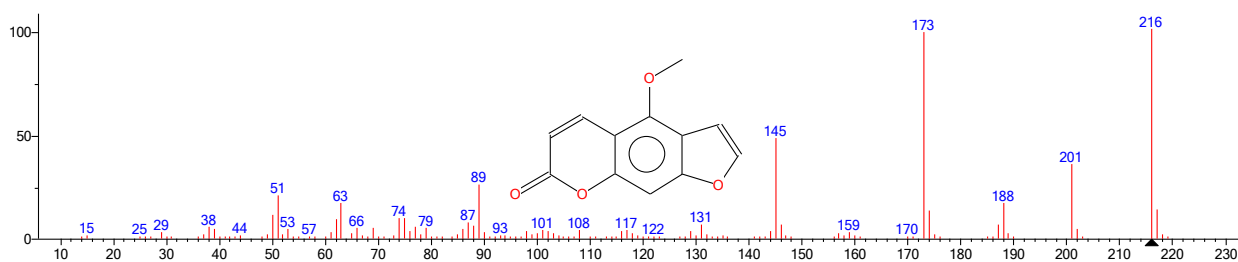


Fig. 12. Isopsoralen $C_{11}H_6O_3$ (12)

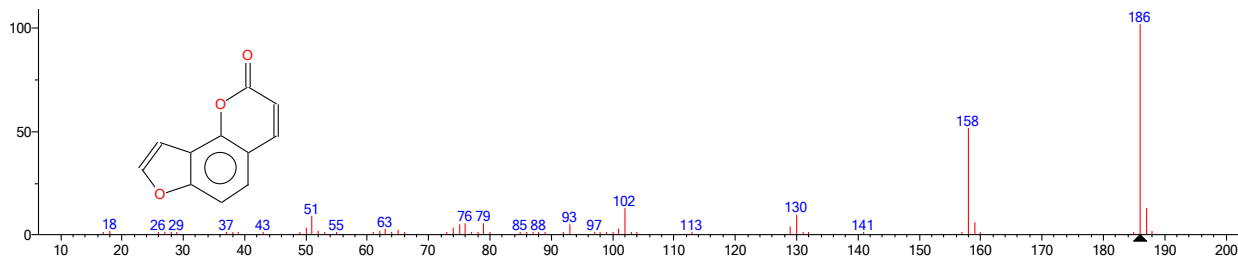


Fig. 13. Angelecin $C_{11}H_6O_3$ (13)

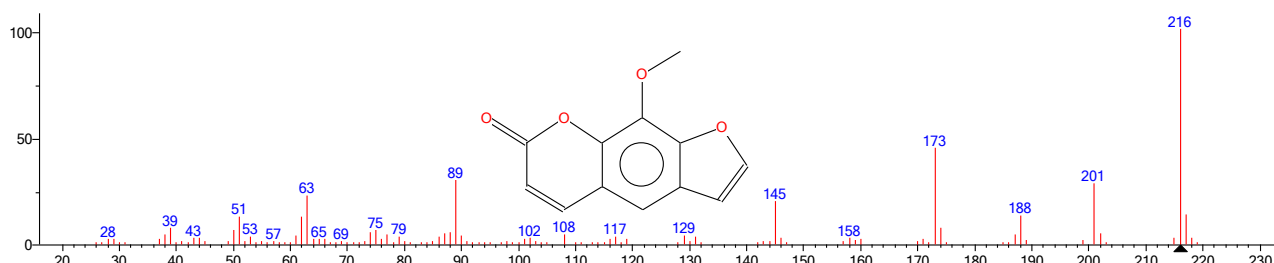


Fig. 14. Methoxsalen $C_{12}H_8O_4$ (14)

Conclusions

1. The distribution area of *Lecokia cretica* (Lam.) DC species in flora of Azerbaijan has been determined in Lankaran.

2. For the first time, via the Gas-Chromatography-Mass-Spectrometry method 6 coumarins and 7 different other components were obtained from the aerial parts of the *Lecokia cretica* plant distributed in the flora of Azerbaijan:

1. D-alanine, N-ethoxycarbonyl-ethyl ester ($C_8H_{15}NO_4$);
2. Butanoic acid, 2,3-dichloro-, methyl ester ($C_5H_8Cl_2O_2$);
3. 2,4,6- Trimethoxystyrene hexadecanoic acid methyl ester ($C_{17}H_{34}O_2$); 4. Hexadecanoic acid methyl ester ($C_{17}H_{34}O_2$); 5. Sesquiterpene lactone- α -santonine ($C_{15}H_{18}O_3$); 6. 2-hydroxy-1-(hydroxymethyl) ethyl ester of hexadecanoic acid ($C_{19}H_{38}O_4$); 7. Diisooctyl phthalate ($C_{24}H_{38}O_4$). Coumarins obtained from the aerial parts of *Lecokia cretica* species: 1. Methoxsalen ($C_{12}H_8O_4$); Bergapten ($C_{12}H_8O_4$); 4. Pimpinellin ($C_{13}H_{10}O_5$); 5. Isopsoralen; 6. Angelecin

3. According to the results using gas-mass-spectroscopy methods, they were identified and the components of the chemical composition of the aerial parts of the species were studied by the GC-MS.

4. Species of this family are widely used in folk medicine due to their anti-inflammatory and antiseptic properties.

Conflict of interests. none

Acknowledgment. The study was carried out within the framework of the scientific research program "Usage prospects of medicinal plants distributed in the flora of Azerbaijan" funded by the Azerbaijan National Academy of Sciences (2022) and the Ministry of Science and Education of the Republic of Azerbaijan (2023).

Study of biologically active substances of the *Laconia cretica* dc. from the family *Apiaceae* lindl.

Sayyara Ibadullayeva, Adely Aleskerova, Aydan Husuyeva, Hilal Imanli, Elvin Kerimli, Emil Shukurlu, Elshan Akhmedov, Oleksandr Maslov, Alla Koval

Introduction. According to the World Health Organisation (WHO), more than 80% of the world population in developing countries primarily uses herbal medicines for their health needs. From this perspective, it is particularly relevant to study for the first time the biologically active substances - coumarin and sesquiterpene lactone nature, which are predominant in the species *Lecokia cretica* belonging to the *Apiaceae* family. **Material and methods.** The object of the study was *Lecokia cretica* (Lam.) DC. In the middle of February, the plant was collected from Lankaran's district Hirkan area. Biologically active substances obtained from species of the *Apiaceae* Lindl. family, such as coumarins, flavonoids, steroids, and sesquiterpene lactones, exhibit a wide range of beneficial activities (including anti-inflammatory, antibacterial, antimicrobial, cardiogenic, anti-malignant, fungicidal, insecticidal). The identification of biologically active compounds in *Lecokia cretica* (Lam.) DC. was carried out by Gas-Chromatography Mass-Spectrometry (GC-MS) method. *Lecokia cretica* is the only representative of the *Lecokia* genus found in Azerbaijan. Only one

species, *Lecokia cretica* belongs to this genus.

Morphological properties: the trunk is straight, furrowed and branched from above, with 30-50 cm height. Fruits are oval, 10-15 mm long. Blooms and bears fruits in May-June. Distribution area: Lankaran mountains, Republic of Azerbaijan. In the middle mountain belt - In shady forests. It is a perennial, bare plant. Only one species, *L. cretica* belongs to the genus. Flowers are bisexual, sometimes unisexual, monoecious, rarely dioecious, generally found in compound umbels, rarely found in simple or hypanthodium. In the lower part of the umbels, there is usually a curtain consisting of several leaves (sometimes 1-2 leaves that fall quickly), and in the lower part of the umbels, there are sepals. Sepals might be present or absent. Petals are usually tiny, 5 pieces, white, pink, yellow, greenish, with 5 stamens. Inferior ovary, two-parted, subcolumnar at the apex (stylopodium, glandular disk), and two columnar; the lower column is usually conical or cushion-shaped, sometimes flat, ring-shaped or cuboidal. The fruit is dry, divided longitudinally into two one-seeded mericarps.

Lecokia cretica is a perennial glabrous plant. Only one species, *L. cretica* belongs to *Lecokia* genus. *Lecokia* is a monotypic genus of flowering plants belonging to the family *Apiaceae*. It just contains one species, *Lecokia cretica* (Lam.) DC. Distribution: . Caucasus. (Talysh).

Worldwide distribution: Balkans.-Malaysia. (Asia Minor), Iran. (northern). In Azerbaijan, it is common in Lankaran Mountains, middle-mountainous area, in shady forests.

Results and discussion. The chromatographic analysis was shown six coumarins and seven various other components were obtained from the aerial parts of the plant: 1. D-alanine, N-ethoxycarbonyl-ethyl ester ($C_8H_{15}NO_4$); 2. Butanoic acid, 2,3-dichloro-, methyl ester ($C_5H_8Cl_2O_2$); 3. 2,4,6-Trimethoxystyrene hexadecanoic acid methyl ester ($C_{17}H_{34}O_2$); 4. Hexadecanoic acid methyl ester ($C_{17}H_{34}O_2$); 5. Sesquiterpene lactone- α -santonine ($C_{15}H_{18}O_3$); 6. Hexadecanoic acid 2-hydroxy-1-(hydroxymethyl) ethyl ester ($C_{19}H_{38}O_4$); 7. Diisooctyl phthalate ($C_{24}H_{38}O_4$). Coumarins obtained from the aerial parts and roots of *Lecokia cretica* species: 1. Methoxsalen ($C_{12}H_8O_4$); 2. Bergapten ($C_{12}H_8O_4$); 4. Pimpinellin ($C_{13}H_{10}O_5$); 5. Isopsoralen ($C_{11}H_6O_3$); 6. Angelicin ($C_{11}H_6O_3$).

Conclusion. The distribution area of *Lecokia cretica* (Lam.) DC species in flora of Azerbaijan has been determined in Lankaran. For the first time, via the GC-MS method 6 coumarins and 7 different other components were obtained from the aerial parts of the *Lecokia cretica* plant distributed in the flora of Azerbaijan. According to the results using gas-mass-spectroscopy methods, they were identified and the components of the chemical composition of the aerial parts of the species were studied by the Chromatography-Mass-Spectroscopy Method. Species of this family are widely used in folk medicine due to their anti-inflammatory and antiseptic properties.

Keywords: *Lecokia cretica*, sesquiterpene lactone, phenolic acids, coumarin derivatives, Gas-Chromatography-Mass-Spectrometry

References

1. Abildaeva F.Zh., Zhangabylov N.S., Adekenov S.M. Prospects for the use of sesquiterpene lactone

- arglabin as an anti-inflammatory and cytotoxic agent. Ministry of Education and Science of the Republic of Kazakhstan Institute of Phytochemistry. Almaty Gylym. 2004, pp. 17-24.
2. Abyshev A.Z., Agayev E.M., Kerimov Yu.B. Chemistry and pharmacology of natural coumarins. Baku: 2003, 112 p.
3. Adekenov S. Sesquiterpene lactones of plants. Distribution in nature, features of the structure of molecules and prospects of their application. In: Int. scientific-practical. conf. "Triterpenoids: achievements and prospects of application in the field of chemistry, production technology and medicine"; 1 січ. 2008; Karaganda, Kazakhstan; 2008. p. 39-62.
4. Alasgarova A, Zeynalova S, Balakci N. With *Centaurea ovina*, *salosifolia* Bieb Let's prepare the foundation for future Diseases. V: Global science and innovations 2022; 1 квіт. 2022; Nur-Sultan, Kazakhstan. Nur-Sultan: Central Asia; 2022. p. 1175-80.
5. Anand P, Singh B, Singh N. A review on coumarins as acetylcholinesterase inhibitors for Alzheimer's disease. Bioorganic Amp Med Chem. 2012;20(3):1175-80. DOI: <https://doi.org/10.1016/j.bmc.2011.12.042>
6. Aras A, Bursal E, Türkan F, Tohma H, Kılıç Ö, Gülçin İ, Köksal E. Phytochemical Content, Antidiabetic, Anticholinergic, and Antioxidant Activities of Endemic *Lecokia cretica* Extracts. Chem Amp Biodivers. 2019;16(10). DOI: <https://doi.org/10.1002/cbdv.201900341>
7. Geydarov I, Serkerov S. Coumarins of *Angelica purpurascens*. Chem Nat Compd. 2017;(1):125-6.
8. Heydarov IG. Chemical study of *Ferula calcarea* M. Pimen., *Prangos biebersteinii* Karjag. and *Angelica purpurascens* (Ave-Lall.) Gilli (Apiaceae) species. [Ph.D. thesis]. Baku: Azerbaijan National Academy of Sciences Institute of Botany; 2018. 20 p.
9. Iranshahi M, Sahebkar A, Takasaki M, Konoshima T, Tokuda H. Cancer chemopreventive activity of the prenylated coumarin, umbelliprenin, in vivo. Eur J Cancer Prev. 2009;18(5):412-5. DOI: <https://doi.org/10.1097/cej.0b013e32832c389e>
10. Kasumova GK, Serkerov SV. A new esterified furocoumarin from *Heracleum pastinacifolium*. Chem Nat Compd. 2013;48(6):955-7. DOI: <https://doi.org/10.1007/s10600-013-0437-z>
11. Ganbarov I. Chemical study of the species *Ferula calcarea* M.Pimin., *Prangos biebersteinii* Karjag., and *Angelica purpurascens* (Ave-Lall.) Gilli (Apiaceae) [dissertation abstract]. Baku: Azerbaijan National Academy of Sciences Institute of Botany; 2018. 20 p.
12. Serkerov S, Aleskerova A. Infrared spectra and structure of sesquiterpene lactones and coumarins. Baku: SVS Production; 2006. 223 p.
13. Serkerov S. Asteraceae and Apiaceae. Baku: CBS Production; 2005. 312 p.
14. Sirota I. Antioxidant effect of arglabin in complex treatment of widespread breast cancer. Almaty: Ministry of Education and Science of the Republic of Kazakhstan Institute of Phytochemistry. Gylym; 2004. 257 p.
15. Taban Akça K, Gürbüz P, Doğan ŞD, Emerce E, Gören AC, Polat R, Süntar İ. Two new eudesmane-type sesquiterpene derivatives from *Lecokia cretica* (Lam.) DC. Nat Prod Res. 2022;1-9.

DOI: <https://doi.org/10.1080/14786419.2022.2153301>
16. Tsetlin A, Nikonov G, Shvarev I. On the issue of antitumor activity of natural coumarins. Plant Resour. 1965;(4):507-11.