OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
SERIES CHEMISTRY AND TECHNOLOGY
ISSN 2224-5286 **https://doi.org/10.32014/2020.2518-1491.67**
Volume 4, Number 442 (2020), 73 – 79

IRSTI 31.25.15

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CHEMICAL CONSTITUENTS OF LIPOSOLUBLE EXTRACT OF *SPIRAEA HYPERICIFOLIA* L.

Abstract. The genus *Spiraea* L., spirea, represents deciduous shrubs of the family *Rosaceae Juss.*, subfamily *Spiraeoideae* Focke. The genus is widespread in the temperate and the subtropical zone of the northern hemisphere having more than 100 species. *S. hypericifolia* L. has the most extensive Eurasian range and is considered one of the most evolutionarily advanced representatives of the genus. In the leaves of *S. hypericifolia* L. detected, p-hydroxybenzoic, coffee, ferulic, chlorogenic acid, flavones apigenin, luteolin and 5-glucosides of flavonols isoquercitrin and avicularin. In this study, chemical constituents of liposoluble extract of *Spiraea hypericifolia* L. were determined for the first time. The components isolated from liposoluble extract of the aerial part of medicinal plant of *S. hypericifolia* L. were analyzed using the GC-MS method. In total, sixty-three compounds were isolated from hexane part and their relative content was determined by normalizing the peak area, in which the main components are octacosanol (9.59%), docosene-1 (8.57%), squalene (8.12%), and n-hexadecanoic acid (7.50%) separately. These compounds have high biological activites, namely anti-inflammatory, antimicrobial, antitumor, antibacterial.

Key words: *S. hypericifolia* L., hexane extract, liposoluble components, GC-MS.

Introduction. The development of medicinal flora and intensive search for new sources of biologically active substances with a wide range of pharmacological effects are very relevant for the development of the pharmaceutical industry. Among the promising sources of plant raw materials are representatives of the genus *Spiraea* L. (*Rosaceae Juss.*).

Species of the genus *Rosaceae Juss* are of considerable interest as plants used in folk medicine and have a great resource potential. Phenolic compounds with high biological activity were found in *Spiraea:* flavonols, flavones, flavans, and phenol-carboxylic acids. Saponins, essential oils and steroid glycosides have been found in various parts of plant species of the genus *Rosaceae Juss.* In Chinese medicine, they are used as medicinal plants with analgesic, antipyretic and anti-inflammatory properties. In modern studies, the biological activity of plant species of the genus *Rosaceae Juss,* associated with the presence of phenol-carboxylic acid derivatives-antimicrobial, phytotoxic [1], has been well studied. Antitumor activity of flavans was detected [2].

Meadowsweet (*Spiraea hypericifolia* L.) is a perennial shrub with a height of 50-150 cm.The leaves are 10-25 mm long and 1.5 - 1.8 mm wide, glabrous or short-pubescent when young, back-oval or lanceolate, whole-edged [3, 4]. In *S. hypericifolia* L., p-oxybenzoic, coffee, ferulic, chlorogenic acids, flavones-apigenin, luteolin and their 5-glucosides, flavonols - isocvercitrin and avicularin, catechins, carotenoids, aromatic carboxylic acids, and vitamin C were found [5-6]. Plants of the genus *Spiraea* are used as a means to relieve headaches of various types, as well as rheumatic joint pain, gastrointestinal diseases, helminthiasis, gynecological diseases. Powerful antibacterial and antiviral action leads to the use with colds and flu, and herpes. The literature does not contain information about the liposoluble composition of species *S. hypericifolia* L., which grows in the Almaty region of Kazakhstan.

The experience of our research group has previously conducted similar studies on the different medicinal plants [7-10]. The purpose of this work is to qualitative and quantitative determine chemical constituents of liposoluble extract of meadowsweet from the Almaty region.

Materials and methods. *Plant material.* The aerial part of the plant material *S. hypericifolia* L. was collected in the Almaty region of Kazakhstan in October 2018. The aerial part of *S. hypericifolia* L. dried in air was cut into small pieces and stored at room temperature.

Extraction and isolation. Naturally dried aerial parts of *S. hypericifolia* L. (100 g) were ground, then extracted with 90% ethyl alcohol (1:8) three times (seven days each time) at room temperature. After evaporation of the solvent at low pressure, the residue was dissolved in water, subsequently the resulting solution was sequentially separated with hexane, dichloromethane, ethyl acetate and n-butanol to obtain the corresponding extracts. The resulting hexane extract was analyzed by GC-MS.

Experimental part. The liposoluble components in the hexane extract of the medicinal plant were analyzed using the GC-MS method. The work was carried out on a gas chromatograph with mass selective detector Agilent 7890A -5975C. Used capillary column HP-5MS length 30 m, internal diameter 0.25 mm, film thickness of stationary phase 0.25 μm. Chromatography conditions: carrier gas-helium; flow rate 1 ml / min; column temperature: initial temperature of 50°C (10 min), temperature rise from 10°C / min from 50°C to 300°C, final temperature of 300°C (40 min), scanning range of 30-1000 AU, electronic shock mode at 70eV. The temperature of the ion source is 230°C. 1 μl of the sample was injected Into the chromatograph evaporator. Samples were introduced by splitting with a 5: 1 split ratio.

Identification of the compounds: Identification of compounds was done by comparing the NIST and Wiley library data of the peaks and mass spectra of the peaks with those reported in literature. Percentage composition was computed from GC peak areas on HP-5MS column without applying correction factors [11].

Results and discussion. In the study, sixty-three chemical components were identified from the hexane part of the aboveground part of *S. hypericifolia* L. plants using the GC-MS method. Their relative content was determined by normalizing the peak area. The GC-MS chromatogram of fat-soluble components from the aboveground part of *S. hypericifolia* L. is shown in figure 1.

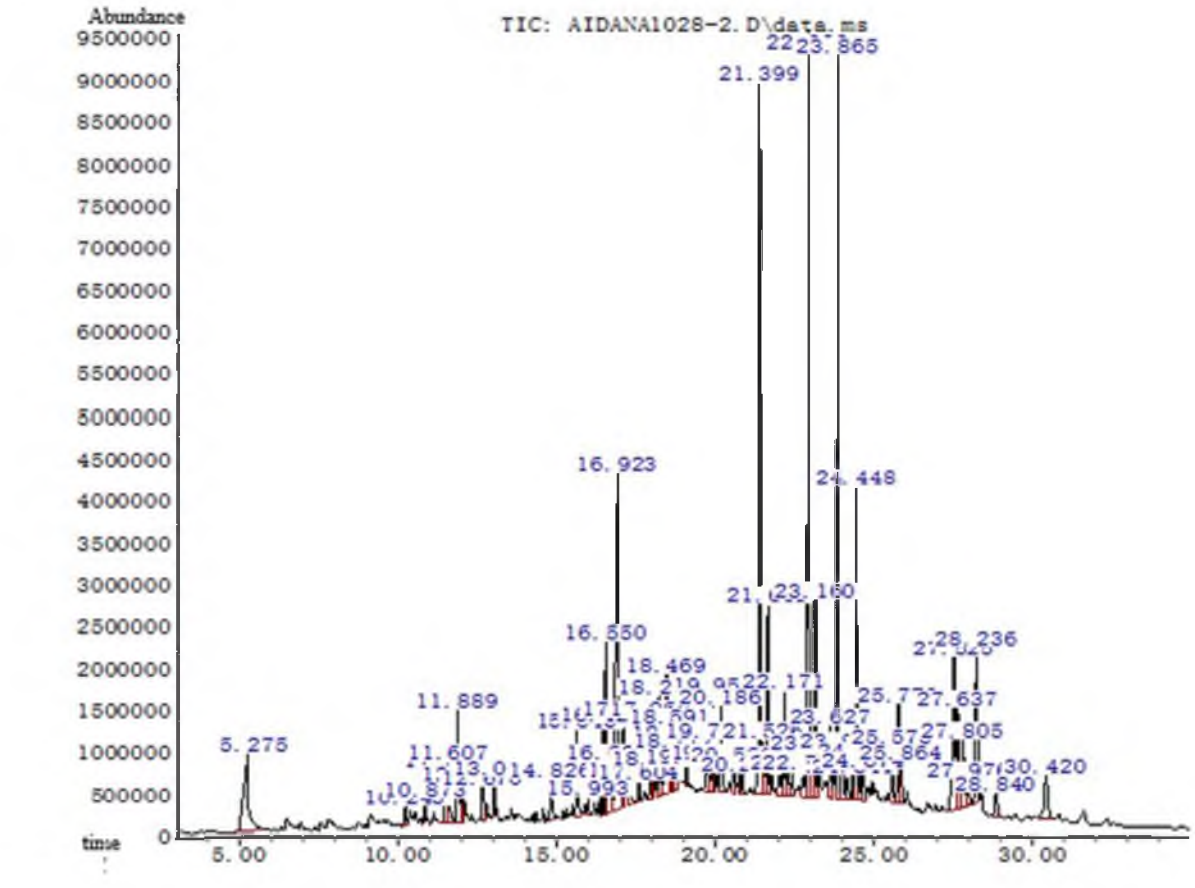

Figure 1 – Total ionization chromatogram of hexane part from *S. hypericifolia* L.

Table 1 shows the main content of liposoluble components from the hexane extract of the aerial part of *S. hypericifolia* L. The fat-soluble content from the hexane extract of the aboveground part of *S. hypericifolia* L. was determined, in which the main components are octacosanol (9.59%), docosene-1 (8.57%), squalene (8.12%), n-hexadecanoic acid (7.50%), linoleic acid (3.88%), gamma.- sitosterol (3.71%), hexanoic acid (3.45%), tridecan, 7-hexyl- (3.40%), lupeol (2.98%).

According to the results, the presence of octacosanol and other biologically active compounds justifies the use of hexane extract of the plant for the treatment of certain diseases. Octacosanol is used for herpetic infections, skin diseases, Parkinson's disease, amyotrophic lateral sclerosis (ALS, Lou Gehrig's disease), high cholesterol and "hardening of the arteries" (atherosclerosis), protects cells, relieves stress and restores sleep disturbed by stress [12-14]. Thus, octacosanol (polycosanol) can be used as a drug or dietary Supplement for the treatment of metabolic diseases without any side effects. Squalene weakens the development of cancer cells, strengthens the immune system, and can increase a person's life expectancy. Squalene, an isoprenoid from the group of polyphenyl compounds, is an intermediate metabolite in the synthesis of cholesterol, possessing antioxidant, immunostimulating, lipid-lowering, cholesterol-lowering, anti-carcinogenic and anti-inflammatory activity [15]; antimicrobial activity, especially against Mycobacterium tuberculosis [16]. In addition, squalene, the main component of the skin's surface polyunsaturated lipids, has a softening, cooling, and antioxidant effect on the skin, as well as antitumor activity [17]. n-hexadecanoic acid shows interesting biological activity against certain diseases and pathogens. For example, the anti-inflammatory, antioxidant, hypocholesterolemic [18], and antibacterial [19] activities described for n-hexadecanoic acid may offer a rationale for the traditional use of this type. These biological activities of the compounds present in *S. hypericifolia* L. extract support the medicinal use of the plant. Studies have identified the main biologically active compounds present in the two extracts. Identification of these compounds in the plant serves as the basis for determining the possible health benefits of the plant, which leads to further biological and pharmacological research.

Table 1 – The liposoluble components from the aerial part of *S. hypericifolia* L.

No.	Name of the compound	Retention time, R_t min	MW	Peak Area %
1	**2**	**3**	**4**	**5**
1	Hexanoic acid	5.279	116	3.45
2	trans-2,3-Epoxydecane	10.24	156	0.28
3	Cyclohexene, 3-(1,5-dimethyl-4-hexenyl)-6-methylene-, [S-(R*,S*)]-	10.877	204	0.26
4	3-Buten-2-one, 4-(2,2,6-trimethyl-7-oxabicyclo[4.1.0]hept-1-yl)-	11.506	208	0.81
5	Benzene, 1-(1,5-dimethyl-4-hexenyl)-4-methyl-	11.608	202	1.01
6	2(4H)-Benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl-, (R)-	11.888	180	2.11
7	Naphthalene, 1,2,4a,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-	12.041	204	0.69
8	Dodecanoic acid	12.67	200	0.75
9	Cedrol	13.043	222	0.45
10	Tetradecanoic acid	14.827	228	0.68
11	2-Pentadecanone, 6,10,14-trimethyl-	15.643	268	1.37
1	**2**	**3**	**4**	**5**
12	Z-8-Hexadecene	15.991	224	0.21
13	Hexadecanoic acid, methyl ester	16.424	270	0.97
14	Dibutyl phthalate	16.552	278	1.92
15	Hexadecenoic acid, Z-11-	16.637	254	1.28
16	n-Hexadecanoic acid	16.926	256	7.50

Continuation of the table

1	2	3	4	5
17	Hexadecanoic acid, ethyl ester	17.087	284	1.18
18	Octane, 1-bromo-	17.291	192	0.55
19	E,Z-2,13-Octadecadien-1-ol	17.605	266	0.27
20	9,12-Octadecadienoic acid (Z,Z)-, methyl ester	17.971	294	1.36
21	9-Octadecenoic acid (Z)-, methyl ester	18.056	296	0.37
22	Sulfurous acid, pentadecyl pentyl ester	18.226	362	1.32
23	Linoelaidic acid	18.472	280	3.88
24	9,12-Octadecadienoic acid (Z,Z)-	18.591	280	1.00
25	6-Nitroundec-5-ene	18.667	199	0.69
26	Oleic Acid	18.71	282	0.71
27	Heptadecane	19.101	240	0.20
28	n-Tetracosanol-1	19.738	354	0.91
29	11-Octadecynoic acid, methyl ester	19.891	294	0.36
30	Tricosane	19.959	324	1.08
31	4,8,12,16-Tetramethylheptadecan-4-olide	20.188	324	1.33
32	2-Methyl-Z,Z-3,13-octadecadienol	20.562	280	0.53
33	Tridecane, 1-bromo-	20.774	262	0.29
34	E-2-Octadecadecen-1-ol	20.876	268	0.23
35	1-Docosene	21.403	308	8.57
36	cis-10-Nonadecenoic acid	21.522	296	1.16
37	Docosanoic acid, methyl ester	21.666	354	2.49
38	Acetate, 2-[(acetyloxy)methyl]-4,4-dimethoxybutyl ester	22.040	248	0.54
39	Undecanoic acid, ethyl ester	22.167	214	1.35
40	1-Acetoxynonadecane	22.295	326	0.55
41	1-Hexacosene	22.431	364	0.38
42	Oxirane, tridecyl-	22.796	226	0.50
43	Octacosanol	22.932	410	9.59
44	Carbonic acid, eicosyl prop-1-en-2-yl ester	23.051	382	0.77
45	Tetracosanoic acid, methyl ester	23.161	382	2.29
46	Hexadecanoic acid, ethyl ester	23.629	284	1.04
47	Squalene	23.866	410	8.12
48	Adenosine, 2-methyl-	23.985	281	0.90
49	2-[2-(Tert.butyl-dimethyl-siloxyl-methyl)-pyrrolidin-1-ylmethyl]-5-methyl-4-phenyl-thiazol	24.164	402	0.45
50	1-Hexacosene	24.342	364	0.36
51	Tridecane, 7-hexyl-	24.444	268	3.40
52	Hexacosanoic acid, methyl ester	24.546	410	0.54
53	Cyclopropanecarboxaldehyde, 2-methyl-2-(4-methyl-3-pentenyl)-, trans-(.+-.)-	24.673	166	0.58
54	Stigmastan-6,22-dien, 3,5-dedihydro-	25.574	394	0.89
55	Cyclohexane, (1-butylhexadecyl)-	25.769	364	1.80
56	6-Methoxy-2,7,8-trimethyl-2-(4,8,12-trimethyltridecyl)chroman	25.863	430	0.58
57	.gamma.-Sitosterol	27.528	414	3.71
58	Stigmastanol	27.638	416	2.14
59	1.alpha.,2.alpha.-Epoxy-1.beta.-methylcholesta-4,6-dien-3-one	27.808	410	1.65
60	30-Norlupan-28-oic acid, 3-hydroxy-21-methoxy-20-oxo-, methyl ester, (3.beta.)-	27.978	502	0.59
61	Lupeol	28.233	426	2.98
62	5.alpha.-Ergost-8(14)-ene	28.836	384	0.59
63	Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene-	30.416	204	1.51

Conclusion. Liposoluble components were extracted with hexane from the aerial part of *S. hypericifolia* L., which were analyzed by GC-MS method. More than sixty-three compounds were isolated from hexane extract. Their relative contents were determined by normalizing the peak areas. For the first time, the active substances of hexane extract of a medicinal plant (*S. hypericifolia* L.) collected in the Almaty region of Kazakhstan were determined. Of the hexane extract, the dominant compounds are octacosanol (9.59%), docosene-1 (8.57%), squalene (8.12%), and n-hexadecanoic acid (7.50%). These compounds have high biological activites, namely anti-inflammatory, antimicrobial, antitumor, antibacterial [15-19]. This shows the need for further research of toxicological aspects for the development of safe herbal medicines.

Acknowledgements. This work was supported by the Central Asia Center of Drug Discovery and Development of Chinese Academy of Sciences (No. CAM202002), the International Partnership Program of Chinese Academy of Sciences (No. 153631KYSB20160004).

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SPIRAEA HYPERICIFOLIA L. МАЙДА ЕРИТІН СЫҒЫНДЫНЫҢ ХИМИЯЛЫҚ КОМПОНЕНТТЕРІ

Аннотация. Дәрілік флораны игеру және фармакологиялық әсерінің кец спектрі бар биологиялық белсенді заттардыц жаңа бастау көзін қарқынды іздеу фармацевтика өнеркәсібін дамытуда өзекті саналады. Өсімдік шикізатының перспективалы бастау көзінің қатарына *Spiraea* L. (*Rosaceae Juss.*) жатады.

Spiraea L., *spirea* түрі *Rosaceae Juss* жапырақты бұта тұқымдасына және *Spiraeoideae Focke* тұқымдасына жатады. *Rosaceae Juss* тегінің түрлері халық медицинасында қолданылатын және үлкен ресурстық әлеуеті бар өсімдіктер ретінде айтарлықтай қызығушылық тудырады. Солтүстік жарты шардагы қоңыржай және субтропикалық аймақта кең таралган 100-ден астам түрі бар. *Spiraea*-да биологиялық белсенділігі жогары фенолды қосылыс ретінде флавонол, флавон, флаван, фенолкарбон қышқылы саналады. *Rosaceae Juss* тектес өсімдіктердің түрлі бөлігінде сапонин, эфир майы, стероидты гликозидтер анықталды. Қытай медицинасында анальгетикалық, ыстықты түсіретін және қабынуга қарсы қасиеті бар дәрілік өсімдік ретінде қолданылады. Қазіргі замангы зерттеулерде фенолкарбон қышқылының антимикробтық, фитотоксикалық туындыларымен байланысты *Rosaceae Juss* тектес өсімдік түрлерінің биологиялық белсенділігі өте жақсы зерттелген. Флавандардың ісікке қарсы белсенділігі анықталды.

Spiraea hypericifolia L. еуразиялық аймақта кең таралған және генетиканың дамыган өкілінің бірі болып саналады. *S. hypericifolia* L. жапырағында п-гидроксибензойн, кофеин, ферула, хлороген қышқылдары, апигенин флавондары, лютеолин және флавонолдардың изокверцитрин мен авикулиннің 5-глюкозидтері анықталды. *Spiraea* тектес өсімдіктер түрлі сипаттагы бас ауруы, сондай-ақ буын, асқазан-ішек ауруы, гельминтоз және гинекологиялық аурулардағы ревматикалық ауруды кетіруге арналган құрал ретінде қолданылады. Күшті антибактериалды және антивирустық әсер ОРЗ, тұмау, герпес кезінде қолдануга себеп болады.

Аталган зерттеудің мақсаты – отандық фитопрепараттарды алу барысында негізгі компоненттердің әлеуетті көзі – Алматы облысы тобылғысының майда еритін компоненттерінің сандық құрамын зерттеу болып саналады.

Бұл зерттеуде алгаш рет *Spiraea hypericifolia* L. майда еритін сыгындысының химиялық құрамы анықталды. *Spiraea hypericifolia* L. дәрілік өсімдігінің жерүсті бөлігіндегі майда еритін сыгындысынан бөлінген компоненттер ГХ-МС әдісі арқылы талданды. Гексан бөлігінен барлығы алпыс үш қосылыс бөлінді және олардың салыстырмалы құрамы шың ауданын қалыпқа келтіру жолымен анықталды, негізгі компоненттер октакозанол (9,59%), докозен-1 (8,57%), сквален (8,12%) және н-гексадекан қышқылы (7,50%) болып саналады. Бұл қосылыстар биологиялық белсенділігі жогары болып келеді, атап айтқанда, қабынуга, микробқа, ісікке, бактерияга қарсы.

Түйін сөздер: *Spiraea hypericifolia* L., гексан сыгындысы, майда еритін компоненттер, ГХ-МС.

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ХИМИЧЕСКИЕ КОМПОНЕНТЫ ЖИРОРАСТВОРИМОГО ЭКСТРАКТА *SPIRAEA HYPERICIFOLIA* L.

Аннотация. Освоение лекарственной флоры и интенсивный поиск новых источников биологически активных веществ с широким спектром фармакологического действия весьма актуальны для развития фармацевтической промышленности. К числу перспективных источников растительного сырья относятся представители рода *Spiraea* L. (*Rosaceae Juss.*).

Род *Spiraea* L., *spirea* представляет собой листопадные кустарники семейства *Rosaceae Juss.*, подсемейство *Spiraeoideae Focke.* Виды рода *Rosaceae Juss* представляют значительный интерес как растения, используемые в народной медицине и имеющие большой ресурсный потенциал. Род широко распространен в умеренной и субтропической зоне северного полушария, насчитывая более 100 видов. В *Spiraea* обнаружены фенольные соединения с высокой биологической активностью: флавонолы, флавоны, флаваны, фенолкарбоновые кислоты. В различных частях видов растений рода *Rosaceae Juss* найдены сапонины, эфирное масло, стероидные гликозиды. В китайской медицине применяются как лекарственные растения с анальгетическими, жаропонижающими и противовоспалительными свойствами. В современных исследованиях достаточно хорошо изучена биологическая активность видов растений рода *Rosaceae Juss*, связанная с наличием производных фенолкарбоновых кислот - антимикробная, фитотоксическая. Обнаружена противоопухолевая активность флаванов.

S. hypericifolia L. имеет наиболее обширный Евразийский ареал и считается одним из наиболее эволюционно развитых представителей рода. В листьях *S. hypericifolia* L. обнаружены п-гидроксибензойная, кофейная, феруловая, хлорогеновая кислоты, флавоны апигенин, лютеолин и 5-глюкозиды флавонолов изокверцитрин и авикуларин. Растения рода Spiraea применяются как средство для снятия головных болей различного характера, а также ревматических болей в суставах, при желудочно-кишечных заболеваниях, гельминтозах, гинекологических заболеваниях. Мощное антибактериальное и антивирусное действие обуславливает применение при ОРЗ, гриппе, герпесе.

Целью данного исследования является изучение количественного содержания жирорастворимых компонентов таволги Алматинской области – потенциального источника ключевых компонентов для получения отечественных фитопрепаратов.

В этом исследовании впервые были определены химические составляющие жирорастворимого экстракта *Spiraea hypericifolia* L. Компоненты, выделенные из жирорастворимого экстракта надземной части лекарственного растения *S. hypericifolia* L ., были проанализированы методом ГХ-МС. Всего из гексановой части было выделено шестьдесят три соединения и их относительное содержание было определено путем нормализации площади пиков, в котором основными компонентами являются октакозанол (9,59%), докозен-1 (8,57%), сквален (8,12%) и н-гексадекановая кислота (7,50%) отдельно. Эти соединения обладают высокой биологической активностью, а именно противовоспалительной, противомикробной, противоопухолевой, антибактериальной.

Ключевые слова: *S. hypericifolia* L., гексановый экстракт, жирорастворимые компоненты, ГХ-МС.

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