COMPONENT COMPOSITION OF ESSENTIAL OILS OF *Artemisia lercheana* AND *A. sieversiana* OF THE FLORA OF KAZAKHSTAN. ANTIMICROBIAL ACTIVITY OF *A. sieversiana* ESSENTIAL OIL

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It is known from the literature that essential oil of *Artemisia sieversiana* Willd. (Sievers sage) possesses antifungal [1], antihelminthic and antimicrobial activity [2], and anti-inflammatory activity *in vivo* due to the azulenes in it [3]. The principal components of its essential oil are camphene, β-pinene, and α-muurolene [4], up to 45% camphor according to one report [5]. Essential oil from raw material freshly collected in Siberia contains also components such as β-myrcene (30.4%), 1.8-cineol (11.7), and germacrene D (10.8); the dried material, β-myrcene (15.5), 1,8-cineol (14.1), and caryophyllene (7.3) [6]. The essential oil provides a source of chamazulene because of its high content in it [7].

Essential oil of *A. lercheana* Kar. et Kir. (Lerch sage) has not been previously studied.

In continuation of the study of the composition of essential oils from plants of the Kazakhstan flora, the component compositions of two types of sage, *A. lercheana* Kar. et Kir. and *A. sieversiana* Willd., were investigated by GC—MS.

Raw material of *A. lercheana* was collected in Western Kazakhstan Oblast in the Sarysu River valley in August 2000; of *A. sieversiana*, in the Karaganda Botanical Garden in August 1998 during flowering. Samples were identified (No. 1988.06.28.04.01 and 1998.07.07.03.02, respectively) and preserved in the herbarium of AO NPTs Fitokhimiya. Essential oil was obtained from dried and ground aerial parts of the plants by steam distillation for 2 h in a Clevenger apparatus. The yield was 0.58% for *A. lercheana* and 0.3% for *A. sieversiana*.

GC—MS analysis of essential oils was carried out under conditions analogous to those in the literature [8]. Table 1 lists the identified components and their percentage content.

A total of 122 components were identified in essential oil from *A. sieversiana*, 85.2% of all observed. The principal components were myrcene, 14.2%; 1,8-cineol, 9.3; linalool, 4.2; *p*-cymene, 3.4; nerylisovalerate, 3.4; and β-caryophyllene, 3.0. A total of 109 components were identified in essential oil from *A. lercheana*, 94.1% of all observed. The principal components were β-thujone, 45.6%; α-thujone, 24.2; camphor, 7.5; and 1,8-cineol, 4.6.

Essential oil of *A. sieversiana* was tested for antimicrobial activity by a microdilution method. The antimicrobial activity was studied under conditions analogous to those previously reported [9]. Table 2 shows that the activity of the essential oil is comparable with that of the reference preparation chloramphenicol succinate toward strain *Enterobacter aerogenes* and is greater than that of chloramphenicol succinate (toward bacteria, *Pseudomonas aeruginosa*) and ketoconazole (for yeast, *Candida albicans*), respectively.

Thus, the principal component compositions of *A. lercheana* and *A. sieversiana* were studied by GC—MS. The study of the antimicrobial activity of essential oil from *A. sieversiana* showed that it was active toward gram-negative strains and yeasts.

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TABLE 1. Composition of Essential Oils from *Artemisia sieversiana* (*A. s.*) and *A. lercheana* (*A. l.*)

Component	RI	A.s.	A.l.	Component	RI	A.s.	A.l.
cis-2-Methyl-3-methylen-5-heptene	947	-	0.1	*cis*-Sabinene hydrate	1556	0.1	Tr.
α-Pinene	1032	1.7	0.1	Octanol	1562	0.1	-
α-Thujene	1035	0.2	0.1	1-Methyl-4-acetylcyclohex-1-ene	1568	0.2	-
Camphene	1076	0.9	0.8	*trans*-*p*-Mentha-2-en-1-ol	1571	Tr.	0.1
β-Pinene	1118	0.7	0.1	Pinocarvone	1586	-	0.2
Sabinene	1132	0.6	0.2	*trans*-β-Bergamoten	1594	0.5	-
Propyl-2-methylbutyrate	1151	0.1	-	β-Ylangene	1589	0.2	-
Butylisobutyrate	1159	0.1	-	Bornylacetate	1597	0.1	0.1
Propylisovalerate	1167	0.1	-	β-Elemene	1600	2.0	-
Myrcene*	1174	14.2	-	Terpinen-4-ol	1611	-	0.7
Isobutyl-2-methylbutyrate	1185	0.2	-	**β-Caryophyllene**	1612	3.0	-
α-Terpinene	1188	-	0.1	2-Methyl-6-methylen-3,7-	1626	0.1	-
2-Methylbutylpropionate	1197	0.3	-	octadien-2-ol			
Isobutyl-3-methylbutyrate (=*isobutylisovalerate*)	1198	0.1	-	***cis*-*p*-Mentha -2-en-1-ol**	1638	Tr.	0.1
2-methylbutylisobutyrate	1203	0.4	Tr.	Dehydrosabinaketone	1643	-	0.4
Limonene	1203	0.5	Tr.	Myrtenal	1648	-	0.1
1,8-Cineol	1213	9.3	4.6	Sabinaketone	1651	-	0.5
Butyl-2-methylbutyrate	1241	0.1	-	Sabinylacetate	1658	-	0.6
(*Z*)-β-Ocimene	1246	0.1	-	Alloaromadendrene	1661	0.1	-
γ-Terpinene	1255	-	0.3	Pulegone	1662	-	0.4
Butyl-3-methylbutyrate (= *butylisovalerate*)	1259	0.1	-	*trans*-Pinocarveol	1664	-	0.4
2-Methylbutylbutyrate	1275	0.1	-	(*Z*)-β-Farnesene	1668	1.8	Tr.
***p*-Cymene**	1280	3.4	1.6	(*Z*)-3-Hexenyltiglate	1681	0.5	-
2-Methylbutyl-2-methylbutyrate	1286	0.5	Tr.	Lavandulol	1686	0.8	-
Terpinolene	1290	-	0.1	α-Humulene	1687	0.4	-
Octanal	1296	0.1	-	Selina-4,11-diene	1688	0.9	0.1
2-Methylbutylisovalerate	1299	0.4	-	(= *4,11-eudesmadiene*)			
(*E*)-2,6-Dimethyl-1,3,7-nonatriene	1319	Tr.	-	(*E*)-β-Farnesene	1695	0.3	-
Propyltiglate	1335	Tr.	-	Carvotanacetone	1697	-	0.1
6-Methyl-5-hepten-2-one	1348	0.1	-	γ-Muurolene	1704	0.2	-
Hexylisobutyrate	1353	0.1	-	α-Terpineol	1706	0.9	-
(*E*)-2-Hexenylisobutyrate	1390	0.7	-	Borneol	1719	2.7	0.3
Nonanal	1400	0.2	-	*trans*-Sabinol	1720	-	0.3
Perillene	1429	0.2	-	Germacrene D	1726	1.6	-
α-Thujone	1430	-	24.2	Carvenone	1737	-	0.1
Hexyl-2-methylbutyrate	1438	0.1	-	β-Selinene	1742	1.9	0.3
β-Thujone	1451	0.1	45.6	Geranial	1742	0.1	-
1-Octen-3-ol	1452	0.2	-	α-Selinene	1744	0.1	-
trans-Sabinene hydrate	1474	0.2	-	Phellandral	1744	-	0.1
Acetic acid	1475	0.1	-	Carvone	1751	-	0.2
(*Z*)-3-Hexenyl-2-methylbutyrate	1482	0.4	-	(*E*,*E*)-α-Farnesene	1758	0.4	-
(*Z*)-3-Hexenyl-3-methylbutyrate	1494	0.3	-	*cis*-Chrysanthenol	1764	-	0.1
(=*(Z)-3-hexenylisovalerate*)				Geranylacetate	1765	-	0.1
α-Copaene	1497	1.2	-	δ-Cadinene	1773	0.4	Tr.
Decanal	1506	0.1	-	β-Sesquiphellandrene	1783	0.3	-
α-Borbonene	1528	0.1	-	*ar*-Curcumene	1786	0.8	0.1
Camphor	1532	-	7.5	Benzylisobutyrate	1797	0.1	-
β-Borbonene	1535	1.7	-	Cuminic aldehyde	1802	-	0.3
cis-α-Bergamoten	1545	0.1	-	Myrtenol	1804	-	0.1
β-Cubebene	1549	0.2	-	Nerol	1808	0.1	-
Linalool	1553	4.2	0.1	*p*-Mentha-1,3-dien-7-al	1811	-	0.1

TABLE 1 (continued)

Component	RI	A.s.	A.l.	Component	RI	A.s.	A.l.
Geranylisobutyrate	1819	0.1	-	Salvial-4(14)-en-1-one	2037	0.1	-
(*E*,*E*)-2,4-Decadienal	1827	0.1	-	(*E*)-Nerolidol	2050	0.5	0.1
(*E*)-β-Damascenone	1838	-	0.1	Humulene epoxide -II	2071	0.2	-
cis-Calamenene	1853	0.1	Tr.	*p*-Mentha-1,4-dien-7-ol	2073	-	0.2
Geraniol	1857	0.1	-	Humulene epoxide -III	2081	0.4	-
p-Cymen-8-ol	1864	0.1	0.1	β-Oplopenone	2092	-	0.1
Nerylisovalerate	1871	3.4	-	(*E*)-Methylcinnamate	2096	-	0.1
Benzyl-2-methylbutyrate	1880	0.2	-	Heneicosane	2100	0.4	-
Geranylisovalerate	1893	2.7	-	Cuminic alcohol	2113	Tr.	0.2
Phenylethylisobutyrate	1896	0.1	-	Hexahydrofarnesylacetone	2131	0.1	0.1
Nonadecane	1900	0.3	-	Spatulenol	2144	2.1	0.2
Benzylisovalerate	1902	0.4	-	(*E*)-Sesquilavandulol	2183	-	0.1
Nerylvalerate	1933	0.1	-	T-Cadinol	2187	0.5	-
4-Isopropylsalicylaldehyde	1940	-	0.1	Nonanoic acid	2192	0.2	0.1
Geranylvalerate	1953	0.1	-	α-Bisabolol	2232	2.3	-
cis-Jasmone	1969	0.2	0.1	Carvacrol	2239	0.1	0.5
Heptadecanoic acid	1981	-	Tr.	*p*-Isopropylphenol	2241	-	0.1
Cuminylacetate	1981	Tr.	0.1	*trans*-α-Bergamatol	2247	0.2	-
(*E*)-12-Norcaryophyll-5-en-2-one	1984	0.3	-	α-Cadinol	2255	0.4	-
2-Phenylethyl-2-methylbutyrate	1988	0.3	0.1	β-Eudesmol	2257	-	0.2
Isocaryophyllene oxide	2001	0.5	-	Tricosane	2300	0.7	-
Caryophyllene oxide	2008	1.5	0.1	Pentacosane	2500	0.2	-
Isoamylphenylacetate	2016	0.6	-	γ-Costol	2533	0.4	-
				Total		85.2	94.1

A. s., content of components in essential oil of *A. sieversiana*; *A. l.*, content of components in essential oil of *A. lercheana*; % calculated from TIC data; *bold letters denote main components; Tr., trace amounts (components less than 0.1% content).

TABLE 2. Antimicrobial Activity of Essential Oil from *A. sieversiana*

Microorganism	Source	MIC	ST
Escherichia coli, Gr(-)	ATCC 25922	125	62.5
Staphylococcus aureus, Gr(+)	ATCC 6538	125	7.81
Pseudomonas aeruginosa; Gr(-)	ATCC 27853	125	250
Enterobacter aerogenes, Gr(-)	NRRL 3567	62.5	62.5
Proteus vulgaris, Gr(-)	NRRL 123	125	31.25
Salmonella typhimirium, Gr(-)	NRRL 4420	125	62.5
Candida albicans, yeast	O. G. U. Tip Fac.	62.5	125-keto

MIC, minimum inhibiting concentration of essential oil from *A. sieversiana*; ST, MIC of standard reference standards chloramphenicol succinate (for bacteria) and ketoconazole (for yeast).

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