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A STUDY OF THE CHEMICAL COMPOSITION OF ESSENTIAL OILS FROM WORMWOOD GROWING IN THE SAMARKAND REGION

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Abstract: This article presents the results of a study of the chemical composition of essential oils of Artemisia absinthium L. and Artemisia vulgaris L., grown in the Samarkand region of the Republic of Uzbekistan. The relevance of this study is due to the widespread use of Artemisia species in the pharmaceutical, food, and cosmetic industries, as well as the need to study the regional characteristics of their chemical profile.

The essential oils were obtained by hydrodistillation from the above-ground parts of plants during the flowering phase. Qualitative and quantitative analysis of their component composition was performed using gas chromatography–mass spectrometry (GC–MS). Differences in the ratios of the dominant components of the essential oils of the studied species were identified, which are related to the species and the ecological and climatic conditions of the growing region.

Keywords: Artemisia absinthium L., Artemisia vulgaris L., essential oil, medicinal plants, component composition, chromatograph mass spectrometry, hydrosteam distillation, wormwood, common wormwood.

I. INTRODUCTION

Today, the need for medicinal plants is growing. Therefore, their in-depth study, identification of their healing properties and development of medicines based on them are considered one of the urgent issues. Despite the fact that the list of medicines is expanding with new drugs every year, many people still continue to use natural medicinal plants.

Wormwood is a plant belonging to the Asteraceae family. It is widespread in the European part of the Commonwealth countries, and is also found in the Caucasus, Western Siberia, Kazakhstan and Central Asia. It grows mainly on vacant and abandoned lands, roadsides and forest edges.

The plant has a short, branched and partially woody root system, and can reach a height of up to two meters. In the first year of its life, adventitious shoots form on the upper part of its branches, and in the second year they develop, bloom and bear fruit. The stem is erect, the upper part is branched and has a silvery-gray color. Wormwood is distinguished by its pungent odor and bitter taste.

The leaves are divided into two or three parts, arranged in long strips at the bottom. The leaves in the middle part of the stem are shorter, have a double pinnate division, and the leaves in the upper part are simple, entire and lanceolate.

In July-August, wormwood produces baskets of small, yellow, tubular flowers. They are spherical in shape and arranged in dense panicles. In August-September, small, oblong, wedge-shaped seeds and fruits ripen. One plant can produce up to 100 thousand seeds, which is its main method of reproduction [1].

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The taxonomy of the genus Artemisia includes more than 200 species, with about 180 species found almost everywhere in Russia and neighboring countries [2].

The most common wormwood plants today include Artemisia absinthium L. (bitter), Artemisia pontica L. (pontic), Artemisia sieversiana Willd. (sieversiana), Artemisia jacutica Drob. (yakutica), Artemisia gmelinii Webb (hemelinii), Artemisia dracunculus L. (tarragon), Artemisia subviscosa Turcz. Ex Bess. (glutinous), Artemisia frigida Will. (cold), and Artemisia vulgaris L. (common) [3].

All of the above-mentioned wormwood species are essential oil crops and are used in various fields of human activity, mainly in cooking, in the production of alcoholic and non-alcoholic beverages, and in medicines and pharmaceutical products [4].

1-Fig. Artemisia wormwood

It is worth noting that the essential oils of some wormwood species may contain compounds with toxic properties, in particular α- and β-thujones. Therefore, a detailed study of the composition of essential oils of plants belonging to the Artemisia genus is scientifically important.

Table 1 presents the main components of the essential oils of some valuable wormwood species growing in the climatic conditions of the Samarkand region.

As can be seen from the table, the chemical composition of essential oils of various wormwood species found in Siberia is quite diverse. However, despite the widespread distribution of one of the most important representatives of this genus, Artemisia vulgaris L. (common wormwood), its essential oil composition has not been sufficiently studied.

Also, different scientists use different methodological approaches in organizing experiments on the extraction of essential oils from plant raw materials. Although there are some commonalities among the methods of extracting essential oils, in practice, steam-assisted separation methods are widely used - hydrodistillation and steam distillation. The duration of the extraction process is usually chosen independently and often lasts from 2 to 6 hours. According to the information provided in the literature [10], the final chemical composition of the essential oil significantly depends on the duration of the extraction process. Therefore, in order to obtain more accurate and reliable information about the chemical composition of the essential oil under study, it is important to carry out the extraction process in full.

The purpose of the work. To study the chemical composition of essential oils obtained from wormwood growing in the Samarkand region, as well as to determine the main biologically active components and their quantitative composition using modern physicochemical analytical methods.

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Research materials and methods. In this study, the above-ground parts of wormwood species (Artemisia absinthium L. and Artemisia vulgaris L.) growing naturally in the Samarkand region were selected as the research object. Plant raw materials were collected in their natural habitats during the growth and flowering period. The collected samples were cleaned of foreign impurities, then dried at room temperature in a well-ventilated, sunlight-protected place until a constant mass was formed. The dried plant material was ground to a uniform state. In order to preserve the quality of the prepared samples, they were stored in dry and dark conditions, in closed paper bags, until the analysis process.

The research used gas chromatography–mass spectrometry (GX–MS) and physicochemical analysis methods.

The qualitative and quantitative composition of essential oils was determined using the gas chromatography–mass spectrometry (GX–MS) method.

Based on the above, it is an urgent task to study the chemical composition of essential oils obtained from the most common representatives of the Artemisia genus growing in the Samarkand region, for example, A. vulgaris L. and A. absinthium L.

A type of wormwood plant	Main components relative to total oil, %	Source obtained
A.absinthium L. (gullash davri)	β-mirsen (Up to 20.0), sabinen (Up to 10,0), α-tuyon (Up to 17,3), β-tuyon (13,6), sabenilatsetat (Up to 21,1)	[4]
A.pontica L. (gullash davri)	1,8-sineol (Up to 18,5), kamfora (Up to 26 gacha), borneol (Up to 12,8), sabinen (Up to 6,5 gacha), xamazulen (Up to 12,3), γ-terpinen (Up to 2,7), terpeniol-4 (Up to 5,6)	[5]
A.jacutia Drob. (gullash davri)	xamazulen (32,4 gacha), γ-yevdesmol (Up to 14,3), 1,8-sineol (Up to 6,1), α-bizabolol (Up to 9,6), β-mirsen (Up to 7,3), neril-3-butanoat (Up to 3,9), neril-2-butanoat (Up to 2,4)	[6]
A.gmelinii Webb. (gullash davri)	kamfora (Up to 39,9 gacha), 1,8-sineol (Up to 17,2 gacha), borneol (Up to 16,4 gacha), bornilatsetat (Up to 3,5), terpeniol-4 (2,5), spatchulenol (1,9), kariofillen-α-oksid (2,5),	[7]
A.dracunculus L. (gullash davri)	metilxavikol (Up to 21,4), 1-fenil-2,4-geksadien(Up to 22,2 gacha), n-simol (Up to 8,7), metilevgenol (Up to 5,4 gacha), limonen (Up to 3,5), spatchulenol (Up to 3,6)	[8]
A.subviscosa Turez. Ex Bess. (g'uncha bog'lash bosqichi)	santolina-trien (17,5), kariofillen (Up to 14,7), germakren-D (7,9), α-gvayen (6,6), β-selinen (7,0), β-elemen (3,2), δ-elemen (2,9),	[9]
A.frigida Will (gullash davri)	kamfora (32,8), 1,8-sineol (14,9), borneol (15,3), bornilatsetat (4,3), terpineol (6,6)	[10]

II. EXPERIMENTAL PART

In order to obtain essential oils from Artemisia absinthium L. and Artemisia vulgaris L. plants, their aerial parts were collected during the flowering period in the Nurabad district of Samarkand region. The collected plant materials were dried under natural conditions for three days in a dry, cool and well-ventilated place. The process of extracting essential oils was carried out in the experimental laboratory using the hydrosteam distillation method.

The chemical composition of the extracted essential oils was analyzed by gas chromatography–mass spectrometry (GC–MS). The analysis was performed using a gas chromatography system equipped with a Varian CP-3800 chromatograph and a 4000 MS quadrupole mass spectrometer. The device used a 30 m long HP-5 quartz capillary chromatographic column (internal diameter 0.25 mm, stationary phase — 6% diphenyl and 94% dimethylsiloxane copolymer). The injector temperature was 282 °C and the ion source temperature was 172 °C. Helium was used as the carrier gas and its flow rate was set to 1 ml/min.

During the chromatographic analysis, the column temperature was maintained at 50 °C for the first 3 min, then the temperature was gradually increased from 50 °C to 272 °C at a rate of 4 °C per minute. In the final stage, the isothermal regime was maintained for 10 min. To ensure the accuracy of the analysis results, an internal standard was used. A standard solution of n-alkanes (C8–C24) was used to determine the reduced retention times of the substances contained in the studied essential oils. Based on these data, the linear retention indices of the components were calculated.

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The identification of components in essential oils was carried out by comparing their reduced retention times, experimentally determined linear retention indices, and data from the NIST 05 and Wiley 07 electronic mass spectral libraries. Agilent ChemStation and AMDIS software were used for this. Data from the mass spectra and retention indices atlas were also taken into account [10].

III. RESULTS AND DISCUSSION

Essential oils of Artemisia absinthium and Artemisia vulgaris plants growing in the Samarkand region were extracted using complete hydrosteam distillation. The process of extracting essential oils from medicinal plant raw materials lasted more than 18 hours for all types of samples and the process was completed when the oil was completely released into the receiver.

Table 2 presents the main technological parameters of the process of extracting the studied essential oils.

Table 2. Technological data of the process of hydrosteam distillation of the studied plant raw materials

Raw material type	Sample mass, g	separated oil mass, g	oil yield, %	properties of oil
A.absinthium L.	680	2,4	0,35	Blue-green, slightly viscous oily liquid
A.vulgaris L.	673	0,9	0,13	Brown, slightly viscous, oily liquid

The results of chromatography–mass spectrometry showed that a total of 90 individual components were identified in the essential oil of A. absinthium L.. Among them, the main share was 1,8-cineole (15.83%) and chamazulene (12.28%). The total amount of these two compounds is about one third of the essential oil. 16 substances with a concentration in the range of 1–10% account for 49.39% of the total oil composition. Also, 55 components with a concentration of 0.1–0.9% have a total share of 21.51%, and 17 compounds with a concentration of less than 0.1% account for less than 1% of the total composition.

In the course of this scientific research, 65 components of wormwood essential oil were identified, which accounted for 82.75% of the total oil composition. Camphor (29.49%) and borneol (14.71%) were identified as the main components in the essential oil of A. vulgaris L. About one third (34.13%) of this essential oil consists of 12 compounds with a concentration of more than 1%. 54 components with individual amounts in the range of 0.1–0.9% account for 22.72% of the total composition. The remaining 0.68% is made up of 8 compounds, each of which is found in an amount of less than 0.1%. In general, 60 substances with a total amount of 94.90% are identified in the essential oil of Artemisia vulgaris.

Detailed information on all components included in the studied essential oils and their quantitative indicators is presented in Table 3.

Table 3. Component composition of the studied essential oils

R.I	Component name	Concentration, % of total fat		R.I	Component name	Concentration, % of total fat	
		A.absinthium L.	*A.vulgaris L.*			*A.absinthium L.*	*A.vulgaris L.*
921	trisiklen	-	0,14	1405	n/a	0,13	0,12
926	α-tuyen	0,11	0,07	1406	metilevganol	-	0,53
932	α-pinen	0,78	0,63	1412	α-gruionen	-	0,10
947	kamfen	0,14	4,06	1416	n/a	0,25	0,09
952	verbinen	0,06	0,08	1422	β-karnofillen	1,28	2,41
973	1-butanol-3-metilpropinoat	0,06	-	1432	β-kopaen	0,34	0,28
973	sabinen	0,60	1,65	1437	n/a	0,07	-
975	β-pinen	0,27	0,41	1448	n/a	0,21	-
991	β-miren	5,11	0,42	1444	β-farnezen	2,29	-
1004	α-fellandren	0,60	0,17	1454	geranilatseton	-	0,34

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1007	izobutil-3-metil butanoat	0,02	-	1456	gumulen	-	0,83
1007	geks-3-en-1-il atsetat	0,05	-	1464	allo-aromadendron	-	0,29
1010	δ-3-karen	0,02	-	1465	n/a	0,15	-
1017	α-terpinen	0,36	0,53	1471	n/a	0,10	-
1024	n-simol	1,00	0,72	1477	selina-4,11-dien	3,51	0,53
1028	β-fellandren	-	0,25	1484	garmakren-D	5,81	4,28
1031	1,8-sineol	15,83	8,77	1488	β-ionon	-	0,28
1038	sis-β-otsimen	0,13	0,31	1490	n/a	0,25	-
1042	n-butil-2-metil-butanoat	0,02	0,09	1493	n/a	0,26	-
1042	benzenatsetaldegid	0,06	-	1496	α-farnezen	-	0,62
1047	n-butil-3-metilbutanoat	0,04	-	1496	zingibiren	0,36	-
1048	trans-β-otsimen	0,04	0,30	1500	bitsiklogermakren	0,51	0,59

IV. CONCLUSION

The results of this study on the composition of the essential oils of A. absinthium L. and A. vulgaris L. growing in the Nurabad district of the Samarkand region showed that these two species of wormwood, which are very similar biologically, are chemically very different from each other.

The composition of the essential oil of A. absinthium L. presented in this study is closest to that of A. gmelinii Webb. and A. jacutica Drob., while the essential oil of A. vulgaris L. studied is closest in composition to that of A. gmelinii Webb. and A. frigida Will.

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