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COMPARATIVE ANALYSIS OF STRUCTURES OF ESSENTIAL OILS OF SOME KIND OF TREE SPECIES *ABIES*

Conditions of the chromatography analysis of essential oils providing an exit of all components with the contents over 0.01% are selected up. Essential oil from five kinds of the fir growing in identical climatic and soil environments is received by the method of hydrodistillation. The qualitative and quantitative analysis of essential oils is carried out. In the structure of essential oils 38 components are identified. The obtained data can be used for practical application of fir essential oils.

Introduction. Coniferous forests play an important role in human society and provide different industries with many raw materials. Almost all parts of the tree are used in the course of wood processing: pine needles, bark, roots, resin, wood, softwood, seeds and cones. The introduction of woody plants that allows attracting some new plants with the best biological and economic properties is essential to increase forest productivity and optimize the environment by means of landscaping. The involvement in forest management of introduced species is widely held to solve this problem nowadays in Belarus.

The most valuable species of conifers introduced in Belarus are various types of fir. Fir (from Latin *Abies*) is a genus of evergreen conifers of pine family (Pinaceae). It has about 50 species that are common in Europe, Asia and North America.

It is well known that a fir needles are a source of biologically active substances obtained in particular from essential oils. Fir essential oil is widely used in various industries. The fir essential oil is currently used in the manufacture of perfumes and dosage forms [1]. As a medicine, it has antiseptic, breast, expectorant, antiscorbutic, calming effect [2]. Being a breast agent it improves the patency of the bronchi, helps with shortness of breath, is useful for patients with asthma and even tones the nervous system. It relieves fatigue and pain in the limbs. Due to the warming effect, the fir essential oil reduces muscle rheumatic and arthritic pain [1, 2].

In reference with the above, the aim of this work was to study the peculiarities of the essential oils of five fir species.

Main part. The objects of study are some essential oils derived from wood green of 40–50-year-old trees Abies (*A. koreana* (I), *A. nephrolepis* (II), *A. homolepis* (III), *A. Fraseri* (IV), *A. holophylla* (V)) growing under the Minsk Central Botanical Garden and BSTU Arboretum in Negoreloye. Needle samples were selected in December 2012 from three trees in order to control the homogeneity of the samples in the autumn and winter months when the yield of essential oil reaches the maximum value and its composition is stabilized.

The selected needles separated from the trunks, crushed to a size of 3–5 mm, the essential oil was distilled from it by hydrodistillation, and the quantitative yield was determined volumetrically.

In addition, such quality integral characteristic as refraction coefficient at 20°C for selected essential oils was analyzed. Some chromatographic methods in combination with the standard (or typical) chromatograms and data of the chemical composition of typical industrial essential oils are traditionally used for quality control and certification of others essential oils [3].

In this regard the qualitative and quantitative analysis of the composition of oils was carried out by gas-liquid chromatography with the help of chromatograph named *Crystal* 5000.1 used silica capillary column of 60 m long with the applied phase – 100% dimethylsiloxane [4]. Chromatographic conditions: isothermal mode at 70°C for 20 min and the following programmed temperature increasing till 150°C with a temperature rise rate of 2°C/min and held at final temperature for 40 min. Evaporator temperature is 250°C.

Chromatography of essential oil in this mode allows to ensure the most complete separation and to identify all components of the composition of essential oil with the content above 0.01%. It is sufficient for the expert work.

Composition of the investigated fir essential oils

No	Name of component	*T*, min	Sample No and components composition, wt %				
			I	II	III	IV	V
1	Santene	25.40	2.79	3.09	0.28	2.77	–
2	Trycyclene	29.51	2.15	2.49	0.74	1.46	1.23
3	α-Thujene	29.69	0.02	0.02	0.05	0.07	–
4	α-Pinene	30.65	18.78	20.07	13.61	8.11	17.41
5	Camphene	32.18	21.62	22.28	11.24	12.64	17.49
6	Sabinene	34.22	0.02	0.03	0.14	0.11	–
7	β-Pinene	34.85	2.76	6.60	2.30	14.01	0.81
8	Myrcene	35.69	1.61	0.50	1.83	1.45	23.47
9	α-Phellandrene	37.50	0.05	0.04	0.17	0.90	–
10	Δ^3-Carene	38.47	0.07	0.23	14.26	7.93	0.09
11	α-Terpinene	38.83	0.04	0.03	0.06	0.06	–
12	p-Cymene	39.11	0.02	0.01	0.03	0.04	–
13	Limonene	40.25	13.51	10.94	25.70	26.60	9.82
14	γ-Terpinene	43.18	0.09	0.08	0.17	0.13	0.03
15	Terpinolene	46.52	0.52	0.52	1.23	0.62	0.41
16	Linalool	46.84	0.04	0.41	0.02	0.31	0.02
17	Camphor	51.36	0.08	0.05	0.13	0,21	0,09
18	Borneol	54,44	4,30	3,82	2,63	2,89	4,91
19	Terpinene-4-ol	55,61	0.02	0.03	0.06	0.08	–
20	p-Cymene-8-ol	56.33	–	0.01	–	–	–
21	α-Terpineol	56.67	0.05	0.20	0.04	0.07	0.03
22	γ-Terpineol	57.64	0.03	0.05	–	0.02	–
23	Bornylacetat	67.03	20.57	19.98	15.03	9.57	16.22
24	α-Longipinene	75.70	0.13	0.25	0.36	0.01	0.47
25	Longicyclene	77.27	–	0.03	–	–	–
26	Geranyl acetate	78.17	0.07	0.05	0.03	–	–
27	Isolongifolene	79.32	0.12	0.20	–	–	–
28	Longifolene	82.80	0.10	0.17	0.11	0.02	0.13
29	β-Caryophyllene	84.25	0.86	0.89	2.10	0.40	3.99
30	α-Humulene	88.99	0.41	0.52	0.79	0.18	0.97
31	γ-Muurolene	92.84	0.06	0.01	0.94	–	0.25
32	γ- Humulene	93.39	0.70	0.06	0.06	–	–
33	β-Selinene	94.15	0.59	0.07	0.09	–	–
34	α-Selinene	94.83	0.06	0.01	0.12	–	–
35	α-Muurolene	95.48	0.45	0.31	0.31	–	0.27
36	β-Bisabolene	96.78	2.49	1.21	–	1.12	0.48
37	γ-Cadinene	98.18	0.14	0.29	0.88	–	0.51
38	δ-Cadinene	99.58	0.62	0.10	1.67	–	0.45
39	Undefined		4.08	4.35	2.82	8.24	0.46

Sighn "–" – content less than 0.01%

Identification of individual components was carried out using reference compounds as well as based on the data published on the retention indices [5].

Essential oils derived from fir wood greens were almost colorless with characteristic balsamic odor of pine needles.

At the exit of essential oil the wood green (sample II (3.2 ml/100 g)) was the most productive raw material, while for the remaining samples the essential oil yield did not exceed 2 ml/100 g.

Refractive index at 20°C of the investigated samples varied in the range of 1.4681–1.4728. The obtained values of this characteristic are so close that do not allow using it as a standard for identification of essential oils of fir.

Individual composition of terpenes and their oxygenated derivatives of fir essential oils were not diverse and remained stable. Number of identified compounds in the analyzed samples of essential oil contained 38 components, their total contribution is about 92 wt %. As you can see from the

Table the main components of the essential oil are Santene, α-Pinene, Camphene, β-Pinene, Bornylacetat, Limonene, Camphor, Borneol. It should be noted, that the quantitative composition of the investigated essential oils significantly changed, while the qualitative composition remained constant. Thus high levels of Camphene and Bornylacetat can be noted for fir samples I, II, V. It is traditional for fir essential oil. At the same time higher content of limonene (25 wt %) and Δ^3-Carene (7–14 wt %) should be noted for the samples III, IV. As a rule some fractions of mono-, sesqui- and terpene hydrocarbons and oxygenates are traditionally marked when considering the composition of essential oils. Such division is primarily associated with the various biosynthesis ways of the components of factions and their functions [6]. According to the Table the essential oil of samples I, II, V is richer with oxygen-containing compounds and sesquiterpene hydrocarbons. It makes these oils more valuable for practical use. In particular, Bornylacetat is 80% and it is a valuable raw material for producing of synthetic camphor.

For oils analyzed in this work, the contribution of the sesquiterpene fraction in the total amount of oil was insignificant (3–5%). The component composition of this fraction of essential oil has not been properly investigated yet. The proportion of undefined compounds is about 50% of the fraction, but it should be noted the change of the content of the main components of this fraction: β-Caryophyllene, γ-Muurolene, γ- and δ-Cadinene.

Conclusion. The essential oil of five introduced fir species growing in natural conditions was obtained.

The productivity assessment of these species was performed. The essential oil yield for these types of fir has a sufficiently high value for coniferous trees. It makes it possible to recommend further study of these samples as a promising source of raw material for production of essential oil.

Qualitative and quantitative composition of the essential oils was investigated. It was determined that the qualitative composition remains constant, but the quantitative composition has significant changes. At the same time a significant contribution to the essential oil of samples I, II, V as valuable biologically active substances can also recommend this raw material for subsequent producing of synthetic Camphor in Belarus.

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