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CONTRIBUTIONS TO THE STUDY OF SOME AROMATIC SPECIES OF THE GENUS *NEPETA* L.

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Abstract: The paper presents a study on four species of aromatic plants: a native species from the spontaneous flora of the Republic of Moldova (*Nepeta cataria* L.), a species to be introduced (*Nepeta racemosa* Lam.) and two non-native species (*Nepeta melissifolia* Lam., *Nepeta grandiflora* M. Bieb.); little research has been conducted on these species, but they are therapeutically valuable. The genus *Nepeta* L. is one of the largest and most important genera in the family Lamiaceae, subfamily Nepetoideae. The studies aimed at their evaluation and characterization from a bio-ecological and phytochemical aspect, in order to highlight the biomorphological peculiarities, the essential oil content and the possibility of using them in aromatherapy, perfumery, phytotherapy and gastronomy. The research highlighted the high adaptive potential and the prospects of cultivation of these species under the pedoclimatic conditions of the Republic of Moldova.

Key words: *Nepeta*, introduction, aromatic plants, composition, essential oil.

Introduction

The main purpose of each botanical garden is to work on introducing plants, in order to enrich the flora of a certain region with new promising species, valuable from economic point of view, with a wide but also rational use of genetic resources. The cultivation of aromatic plants in our country, after a long period of stagnation, is slowly recovering. Currently, there is an active interest in studying these plants, as they are a natural and local source of raw material. People, knowing the properties of these plants, gradually expanded their scope of application in various branches of the national economy: aromatherapy, phytotherapy, perfumery and food. The growing demands contributed to the fact that many peoples tried to identify promising plant species in their homeland, others to introduce them, which led to the creation of collections of aromatic and medicinal plants specific to each country. Such a collection has also been created in the "Alexandru Ciubotaru" National Botanical Garden (Institute), Chișinău.

Among the many genera of aromatic plants present in the collection, the genus *Nepeta* L. is of particular importance, being represented in the spontaneous flora of the Republic of Moldova by three species: *N. parviflora* Bieb., *N. pannonica* L. and *N. cataria* L. The following species have been introduced and researched in the collection of the "Alexandru Ciubotaru" National Botanical Garden (Institute), Chișinău: *Nepeta cataria* L., *Nepeta racemosa* Lam., *Nepeta melissifolia* Lam., *Nepeta grandiflora* M. Bieb., *Nepeta kokanica* Regel, which have served as research subjects.

Materials and methods

The research was initiated in 2019 and included observations on the species of the genus *Nepeta* L., presented in the collection of aromatic plants: *Nepeta cataria* L., *Nepeta*

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racemosa Lam., *Nepeta melissifolia* Lam., *Nepeta grandiflora* M. Bieb., *Nepeta kokanica* Regel. The plants were grown in plots, on a south-facing field, under ecologically balanced conditions, on a general agrotechnical background. Phenological observations were made according to the method used in botanical gardens, with slight modifications depending on the peculiarities of each species, throughout the growing season [Metodica fenologhiceschih nabliodenii v botaniceschih sadah SSSR, 1979]. The essential oil content was determined by steam distillation [Gosudarstvenaia farmacopeia SSSR, 1968]. During the growing season, observations were made on the reaction of plants to late spring frosts, resistance to low temperatures, the influence of light intensity, the insufficiency and excess of atmospheric precipitation and the resistance of plants to diseases and pests. The phytochemical compounds of the essential oil were determined at "Stejarul" Biological Research Center, Piatra Neamț, Romania, with the help of the gas chromatograph Agilent Technologies tip 6890N coupled to the mass selective detector (MSD) 5975 inert XL MSD, by gas chromatography mass spectrometry (CG/MS).

Results and discussions

One of the species included in the research is *Nepeta cataria* L. (Figure 1, a) species introduced from the spontaneous flora of the Republic of Moldova, herbaceous, perennial plant, which has numerous fibrous roots in the soil starting from a woody, branched rhizome. The stem is erect, vigorous, and square, with short hairs. Under the conditions of the botanical garden, it reaches 40-60 cm in height. The leaves are triangular ovate with acuminate tip. The inflorescences are spikes, with flowers located in the axils of the leaves in the upper part of the shoots. The flowers are pink, grouped in dense whorls, arranged at the base of the leaves from the top of the stem. The flowering stage occurs between July 25 and August 15. The fruits are ellipsoidal, brown, smooth nutlets. The natural range of this species includes Western Europe and Asia, up to the Himalayas. In the spontaneous flora of the Republic of Moldova, it occurs sporadically, it grows in meadows and forest edges, thickets, ruderal and stony areas. The biologically active substance is the essential oil, which is contained in the non-lignified aerial part. The maximum content is recorded in the full flowering stage and is 0.24-0.30%, in inflorescences – 0.32-0.41%. The main compounds of the essential oil are: carvacrol, thymol, citral, nepetalactone, nepetalic acid, nepetal-glucoside-ether, limonene, geraniol, caffeic acid, ursolic and rosmarinic acid, coumarins and flavonoids. The plant product possesses therapeutic properties, such as: antispasmodic, antitussive, astringent, carminative, gastrointestinal stimulant, tonic, sedative, emmenagogue, diuretic and cholagogue [ARDELEAN & MOHAN, 2008]. It is beneficial in neurological disorders, chest pains, and improvement of digestion by stimulating gastrointestinal secretions, stimulation of salivation and toothache relief. The essential oil obtained from the plant is used in the perfume and cosmetic industry, in the production of soaps [TELEUȚĂ & al. 2008]. The aerial part of the plant is part of the aromatic herb mixture used in the production of vermouth. The leaves and shoots are used to flavour sauces and soups. The leaves are used to flavour tea.

Nepeta racemosa Lam. (Figure 1, b) is a perennial herbaceous plant, introduced from the Nikita Botanical Garden, Yalta, Crimea, which has, in the soil, fibrous roots starting from a woody, branched rhizome. The stem is erect, densely pubescent, vigorous, square, under the climatic conditions of our country, it reaches 30-40 cm in height. The leaves are cordate-ovate rarely oblong-ovate. The inflorescence consists of several false whorls, of which 3-4 grouped at the top and another 1-3 whorls are spaced. The corolla of the flower is blue-purple, white

pubescent outside, the lower lip is twice as long as the upper one, with a large central lobe and obliquely semicircular side lobes. It blooms all summer long. The fruits are ellipsoidal, smooth, brown-black nutlets that ripen at the end of June. The species occurs, under natural conditions, in the Caucasus. This species has been successfully introduced in Crimea and the Republic of Moldova. The perennial plants start the growing season at the beginning of March, they bloom in the period from June to August. The seeds ripen in the last days of September. The plants synthesize essential oil in all organs. The raw material harvested during the summer contains 0.20-0.22% essential oil and the material harvested in autumn – 0.15-0.18%. If cultivated, it grows well on calcareous, humic, structural soils. The plants are frost-tolerant. They withstand low temperatures, down to -25-30 °C. In the Republic of Moldova, if irrigated, this species gives up to three harvests. It can be propagated only vegetatively, by cuttings or by division. The essential oil contains nepetalactone, germacrene, citral, citronellol, geraniol, nerol, mucilage, saponins, etc., and it exhibited antioxidant activity and antibacterial properties against *Escherichia coli* microorganisms [MOLLOVA & al. 2023]. The plant product has diuretic, analgesic, anti-inflammatory, anxiolytic, sedative, hypnotic, antispasmodic, astringent, antitussive and antimicrobial effects [RABOTEAGOV & ACSENO, 2014]. The essential oil is used in the perfume and cosmetic industry, particularly to produce soaps. The leaves and tops of the plant stems harvested in the full flowering stage are used as a spice. The fresh and dried leaves are added to teas for a cooling and flavouring effect. They contain high amounts of vitamin C, therefore have calming effect, help treating colds and fever and improve appetite. In landscaping, it is used as an ornamental plant, resistant to drought, with long flowering period, which makes it possible to use this species successfully in the design of gardens, over which pollinators will gather, attracted by the honey flowers.

Nepeta melissifolia Lam. (Figure 1, c) is an herbaceous, perennial plant introduced into the Botanical Garden by seed exchange from the Bordeaux Botanical Garden, France. It has ascending stems, growing 40-60 cm tall, ovate-cordate leaves, up to 3.5 cm long, pubescent. The flowers are up to 1.5 cm long, blue with red dots, in spike inflorescences. They are native to Crete and the Aegean Islands [BHAT & al. 2018]. It grows among bushes on rocky slopes. Under the climatic conditions of our country, the plants start growing at the end of April. The budding stage occurs in the middle of June. It blooms between July and August. The growing season lasts for 135 days. The flowers are attractive to bees. The biologically active substance is the essential oil, which is contained in the non-lignified aerial part, in the full flowering stage reaching 0.20-0.30%, in inflorescences 0.25-0.35%. The basic compounds of the essential oil are: nepetalactone, nerol, geraniol, geranial, β-Caryophyllene, linalool, carvacrol, thymol, citral, nepetalic acid, nepetal-glucoside-ether, limonene, β-pinene, etc. (Table1, Figure 2).

Nepeta grandiflora M. Bieb. (Figure 1, d) is a perennial, hemicryptophyte, obtained by international seed exchange from Germany. The plant has a square, light green, slightly branched stem and fibrous root. The leaves are opposite, crenate, toothed. The flowers – violet, grouped in terminal whorls. Fruit – brown nutlet. It is researched as an aromatic and medicinal plant, which contains essential oil (0.31-0.42%). Under the conditions of our country, it reaches 50-75 cm in height. Plants go through the entire development cycle, synthesize essential oil (0.31-0.42%). In the essential oil obtained from the aerial parts of the plant, 25 chemical compounds were identified, the main ones being: germacrene D, eucalyptol, etc. (Table 1, Figure 3).

In folk medicine, it is a perfect remedy for reducing blood pressure, a good sedative for hyperactive children and it improves digestion [RABOTEAGOV & ACSENO, 2014].

Nepeta kokanica Regel. is an herbaceous, perennial species, obtained in 2021 by the International Seed Exchange from Germany. It has numerous stems, 10-35 cm tall, ascending

or erect, strongly branched, covered with long white hairs. The leaves are light green, 1.5-2.5 cm long and 1-2.2 cm wide, ovate, with serrated edges. The flowers are grouped in false whorls, forming an ovoid inflorescence of bright blue colour. The fruit is an elongated, brown nut. It blooms in July-August. It is able to complete the entire cycle of vegetation. It is currently under research.

Figure 1. Plant species of the genus *Nepeta* L.
a – *Nepeta cataria* L.; b – *Nepeta racemosa* Lam.;
c – *Nepeta grandiflora* M. Bieb.; d – *Nepeta melissifolia* Lam.

Table 1. The chemical composition of the essential oil of the species *Nepeta melissifolia* Lam. and *N. grandiflora* M. Bieb.

TR (min)	Kovats Index	Compounds	Area %	
			N. melissifolia	*N. grandiflora*
5.65	922	α-Thujene	0.1	0.1
5.85	930	α-Pinene	0.2	1.5
6.91	974	Sabinene	0.2	3.7
7.03	978	β-Pinene	0.9	5.6
7.19	985	3-Octanone	0.2	0.4
7.39	992	β-Myrcene	0.1	1.1
8.50	1026	p-Cymene	0.4	0.1
8.66	1030	Limonene	-	1.9
8.74	1033	Eucalyptol	0.2	27.1
8.93	1038	*trans*-β-Ocimene	0.2	2.2
9.31	1048	*cis*-β-Ocimene	0.5	2.3
11.21	1101	Linalool	2.0	0.3
14.35	1181	4-Terpineol	0.4	0.5
14.90	1194	α-Terpineol	0.2	0.2
15.57	1210	3-Terpinen-1-ol / *p*-Menth-3-en-1-ol	0.1	-
15.89	1217	Dihydro myrcenol acetate	0.2	-
16.47	1231	Nerol	8.5	-
16.98	1242	Neral	1.6	-
17.58	1256	Geraniol	5.7	-
18.23	1271	Geranial	2.0	-
19.17	1292	Thymol	0.1	-
19.57	1301	Carvacrol	0.8	-
21.99	1359	(4aS,7S,7aS)-*trans*,*cis*-	22.9	-
22.78	1378	α-Copaene	-	0.2
23.15	1388	β-Bourbonene	-	0.7
23.20	1388	(4aS,7S,7aR)-*cis*,*trans*-	47.6	-
23.39	1393	(4aR,7S,7aS)-*cis*,*cis*-Nepetalactone	2.1	-
23.44	1394	β-Elemene	-	1.0
24.56	1422	β-Caryophyllene	1.3	12.3
25.92	1455	α-Humulene	0.1	0.7
27.02	1482	Germacrene D	0.1	28.0
27.65	1498	Bicyclogermacrene	-	1.3
28.11	1510	α-Farnesene	-	0.4
28.70	1525	δ-Cadinene	-	0.3
30.95	1584	Spathulenol	0.9	4.1
33.61	1655	τ-Cadinol	-	0.5
		Other compounds	*0.5*	*3.5*

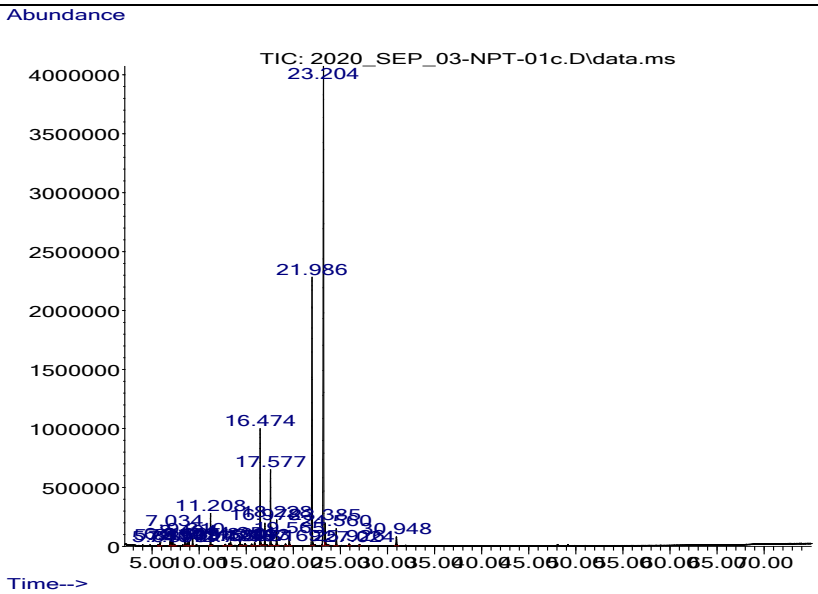

Figure 2. GC-MS chromatogram of *Nepeta melissifolia* Lam.

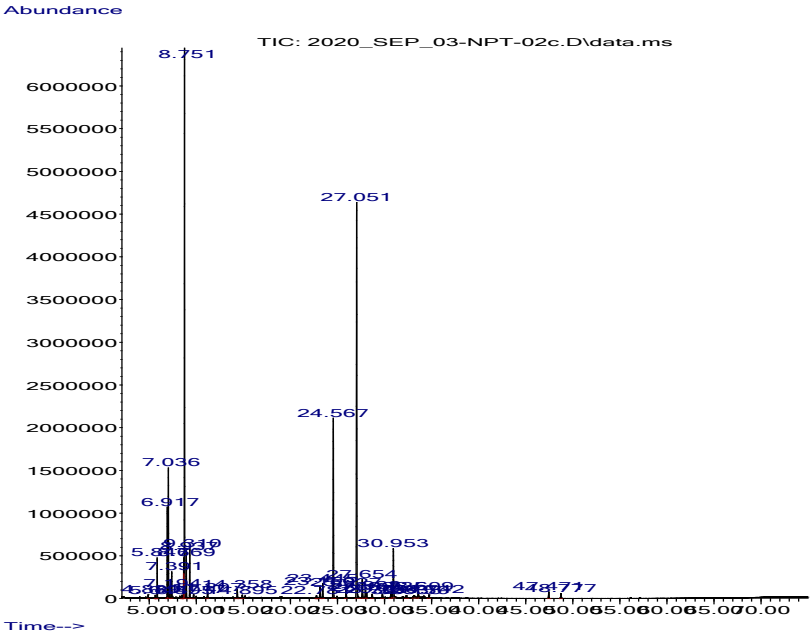

Figure 3. GC-MS chromatogram of *Nepeta grandiflora* M. Bieb.

Conclusions

The pedoclimatic conditions of Moldova are favourable for the growth and development of plants of the genus *Nepeta* L. They fully complete the ontogenetic cycle. The essential oil content varies among the plant species. The highest content was found in the species *Nepeta grandiflora* M. Bieb. (0.31-0.42%), followed by *Nepeta cataria* L. (0.29-0.40%). The species *Nepeta grandiflora* M. Bieb. is the tallest (50-75 cm), followed by *Nepeta melissifolia* Lam. (40-60 cm). The introduced species fully complete the ontogenetic cycle. The plants bloom and bear fruit starting from the 2nd year of vegetation. They synthesize essential oil.

The conducted research on the chemical composition of essential oil produced by the introduced species, under the conditions of the Republic of Moldova, indicates that in *Nepeta melissifolia* Lam. the main compound is (4aS,7S,7aR)-*cis*, *trans*-Nepetalactone (47.8%), followed by (4aS,7S,7aS)-*trans*, *cis*-Nepetalactone (22.9%), nerol (8.5%), geraniol (5.7%), geranial (2.0%). The presence of nepetalactones is frequent in the essential oils produced by species of the genus *Nepeta*. According to the obtained data, the composition of the essential oil from the species *N. grandiflora* M. Bieb. differs in the predominant presence of the compound Germacrene D (28%), followed by β-Caryophyllene (12.3%), β-Pinene (5.6%), Spathulenol (4.1), Sabinene (3.7%) etc.

The species of the genus *Nepeta* L. introduced and researched in the National Botanical Garden (Institute) can serve as sources of local raw material for the production and diversification of the range of natural cosmetic and pharmaceutical products of plant origin. All species are excellent honey plants.

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