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ASPECTS OF THE STUDY ON SOME AROMATIC SPECIES OF THE GENUS *AGASTACHE* GRONOV

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The study has been focused on the field of introduction, conservation and use of aromatic and medicinal plants, which represent inexhaustible sources of raw materials for the pharmaceutical, cosmetic and food industries. The article describes the results of the evaluation of the prospects for the introduction of 4 species of the genus *Agastache* Gronov: *Agastache foeniculum (* Pursh) Kuntze, *Agastache rugosa* (Fisch & C. A Mey.) O. Kuntze, *Agastache urticifolia* (Benth.) Kuntze, *Agastache nepetoides* L., species that have not been studied in much detail, but of high therapeutic value. The studies focused on the bio-ecological and phytochemical research on the plants, in order to highlight the biomorphological peculiarities, the essential oil content and the possibility of using them in various branches of the national economy. Far from being an exhausted source of remedies, natural products continue to provide low molecular weight compounds with important biological properties that can be used for pharmaceutical purposes.

Keywords: *Agastache, aromatic plants, introduction, use, essential oil.*

ASPECTE PRIVIND STUDIUL UNOR SPECII AROMATICE DIN GENUL *AGASTACHE* GRONOV

Studiul este consacrat domeniului de introducere, conservare și valorificare a plantelor aromatice și medicinale, care reprezintă surse inepuizabile de materii prime pentru industria de medicamente, cosmetică și alimentară. Lucrarea este axată pe evaluarea perspectivelor de introducere a 4 specii din genul *Agastache* Gronov: *Agastache foeniculum (* Pursh) Kuntze, *Agastache rugosa* (Fisch & C. A Mey.) O. Kuntze, *Agastache urticifolia* (Benth.) Kuntze, *Agastache nepetoides* L., specii mai puțin investigate, dar valoroase din punct de vedere terapeutic. Studiile au vizat cercetarea sub aspect bio-ecologic și fitochimic a plantelor, în scopul evidențierii particularităților biomorfologice, conținutului în ulei volatil și a posibilității de valorificare în diverse domenii ale economiei naționale. Produsele naturale sunt departe de a fi o sursă epuizată de remedii, acestea continuă să furnizeze compuși cu masă moleculară mică, cu proprietăți biologice importante, care pot fi exploatate în scopuri farmaceutice.

Cuvinte-cheie: *Agastache, plante aromatice, introducere, valorificare, ulei volatile.*

Introduction

The introduction, conservation and use of the diverse range of aromatic and medicinal plants, accumulated in the gene pool of the Botanical Garden, remains one of the long-term priority tasks.

The therapeutic and cosmetic properties of plants have been rediscovered, their role in the life of modern people has become undeniable, both due to their numerous usages and due the fact that they offer a promising alternative in maintaining health and beauty. Year by year, there has been an increase in the trend of using plants in the treatment of many diseases with remedies of natural origin. This is due to the fact that such remedies have practically no side effects. Therefore, there is a need to know and research aromatic and medicinal plants in all aspects and to obtain effective medicinal preparations based on them. Satisfying the ever-increasing demands of the population for herbal medicinal raw material can only be possible after carrying out the respective scientific research, followed by the establishment of plantations of the desired assortment.

The genus *Agastache* Gronov, synonym *Brittonastrum*, which includes about 22 species of aromatic and medicinal perennial plants, is of particular importance among the many genera of aromatic plants in the Lamiaceae family. These species originate from the dry hilly areas of the USA, Mexico, Japan and China. A long

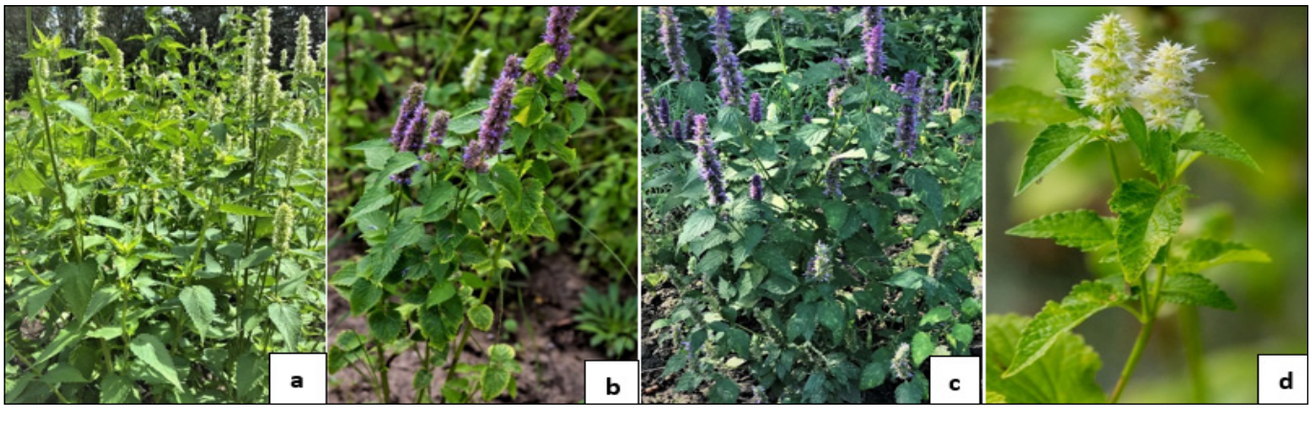
flowering period is characteristic of most of them, thus they are considered excellent honey plants. They are used not only for their medicinal and cosmetic properties, but also as spices in various food recipes, in making teas and soft drinks. These species are also used as ornamental plants, which are grown in gardens either alone or mixed with other species, particularly in borders. They are easily cultivated, as they develop quickly, preferring moist, well-drained soil and sunny areas. The species of the genus *Agastache* are aromatic plants, which are well-known sources of bioactive principles, especially essential oil of particular economic importance.

Material and Methods

The research was carried out in 2019-2023, the research subjects being 4 species of plants of the genus *Agastache* Gronov: *Agastache foeniculum* (Pursh) Kuntze, *Agastache rugosa* (Fisch & C.A Mey.) O. Kuntze, *Agastache urticifolia* (Benth.) Kuntze, *Agastache nepetoides* L., all introduced in the collection of aromatic plants of the Botanical Garden from other regions. The plants were grown in plots, in an open field with southern exposure, under ecologically balanced conditions, on a general agrotechnical background. Phenological observations were made according to the method described by I.N. Beidemann, during the entire growing season [1]. The essential oil content was determined by steam distillation [2]. 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, 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) [3].

Results and Discussions

Figure 1. **The general aspect of species of the genus Agastache GRONOV in the generative phase:** a - *Agastache foeniculum* (Pursh) Kuntze, **b** - *Agastache rugosa* (Fisch & C.A.Mey.) O. Kuntze. **c -** *Agastache urticifolia* (Benth.) Kuntze, **d** - *Agastache nepetoides* L.



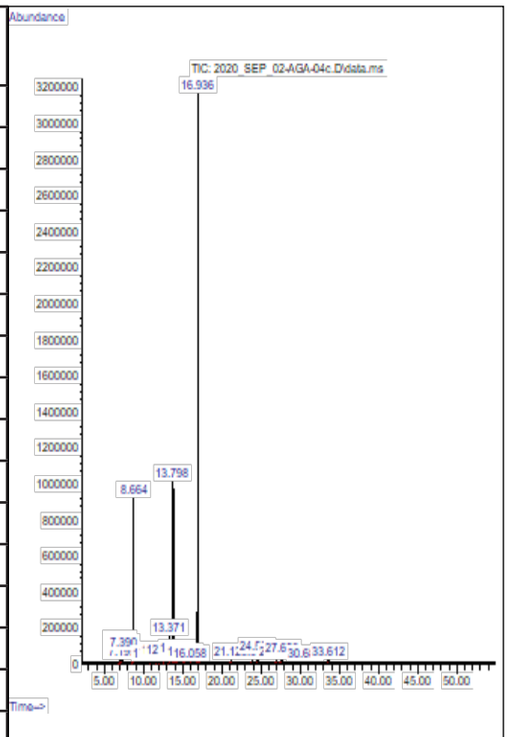
***Agastache foeniculum* (Pursh.) Kuntze (**anise hyssop) (Figure 1. a**)** is a perennial, vigorous species, native to the central areas of North America, where it has expanded to the Canadian provinces. Under the climatic conditions of the Republic of Moldova, the perennial plants of *Agastache foeniculum* (Pursh) Kuntze, during the growing season, are characterized by the presence of 12-14 annual shoots, which start growing in the middle of April. An intensive growth is observed starting from the beginning of June. *A. foeniculum* plants enter the budding stage in early June, which lasts 30-35 days. As a result of the growth of shoots of different orders, the plant takes the shape of a bush. The beginning of the flowering stage occurs in the middle of July; therefore the full flowering takes place at the beginning of August. It blooms during a long period, lasting 75-90 days. It has small, tubular flowers arranged in terminal spikes that are about 4-8 cm long, blue, purple, pink or white, which produce a strong fragrance similar to that of anise. During this period, it has a bushy appearance, being completely covered by shoots. At the end of September, the fruit ripening stage occurs. The research carried out on the growth and development characteristics of the *A. foeniculum* plants has demonstrated that, under the climatic conditions of the Republic of Moldova, they go through the entire vegetation cycle, including the formation of viable seeds. The duration of the growing season of these plants is about 200-220 days.

Two-year-old plants develop a bush composed of 4-6 stems that grow 1.0-1.2 m tall and green, lanceolate leaves with a pointed tip and evenly toothed margins. The number of leaves on the central axis is 80-84, with 2-2.2 cm long petiole. The flowers are small, grouped in elongated inflorescences. It is propagated by seeds, which are sown shortly before the late spring frosts occur, at temperatures of 15-18 °C, covered with a 1 cm thick layer of soil, because light helps germination. It can also be propagated by division, in early spring, or by cuttings taken from young basal shoots that started growing in spring. *A. foeniculum* plants produce essential oil during the entire growing season, but its amount varies depending on the age of the plant and the stage of development. The content of essential oil in the species *A. foeniculum*, determined in the full flowering stage, in 2-year-old plants, was 0.40-0.45% in the green mass and 1.40-1.60% in the absolutely dry matter, respectively. The essential oil contains camphor, estragole, limonene, anisole, linalool, methyl chavicol, menthone, pulegone, eugenol [4].

***Agastache rugosa* (Fisch & C.A.Mey.)** O. Kuntze. (wrinkled giant hyssop) (Figure 1. b). The native range of this species is Asia, namely China, Japan, Korea, Siberia. Under the climatic conditions of the Republic of Moldova, the perennial *A. rugosa* plants are characterized by the presence of 7-11 annual shoots, which start growing at the end of March. A slow growth was observed, because of the low temperatures recorded during the given period. Starting with early June, the plants began to grow intensively, reaching a height of 80-110 cm. *A. rugosa* plants reached the budding stage at the end of June. The beginning of the flowering stage was recorded in early July. The flowering stage lasted 60-75 days, as it depended on the weather conditions during the given period. Wrinkled giant hyssop plants bore fruit starting from the first year of vegetation. The seed ripening stage began in the middle of September and lasted 30-45 days. The plants went through the entire development cycle. They are hardy plants, withstanding low temperatures. *A. rugosa* can be cultivated as a medicinal plant, for its antibacterial, antifungal, carminative and antipyretic properties. The young leaves can be eaten fresh or cooked, but are normally used to add flavour to salads. The content of essential oil in the full flowering stage was 0.68 - 0.72% of the absolutely dry matter. In order to identify some new biological compounds, we researched the chemical composition of the essential oil of *A. rugosa* plants grown under the climatic conditions of the Republic of Moldova.

Tab. 1. The chemical composition of the essential oil of Agastache rugosa determined by GC-MS.

RT (min)	Kovats index	Compounds	Area %
6.91	973	Sabinene	0.1
6.97	976	3-Cyclohepten-1-one	1.1
7.19	985	3-Octanone	0.2
7.39	993	β-Myrcene	0.8
8.66	1030	Limonene	12.3
11.68	1113	1-Octenyl acetate	0.2
12.02	1122	1,3,8-ρ-Menthatriene	0.4
12.59	1136	cis-ρ-Mentha-2,8-dien-1-ol	0.4
13.37	1155	Menthone	2.5
13.80	1166	iso-Menthone	16.9
14.26	1178	cis-Linalool oxide (furanoid)	0.7
15.21	1202	Estragole	0.1
16.93	1241	Pulegone	60.8
21.15	1340	Piperitenone	0.4
23.84	1404	Methyl eugenol	0.3
24.56	1422	β-Caryophyllene	0.9
27.66	1498	Bicyclogermacrene	0.6
		Other compounds	1.2



GC-MS chromatogram of *Agastache rugosa.*

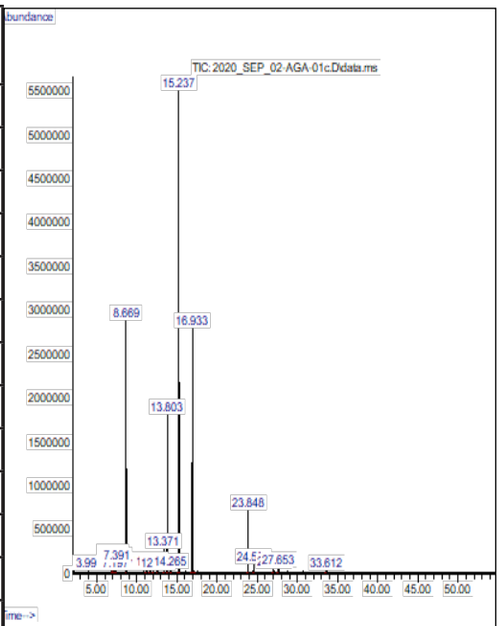
The research carried out characterizes the essential oil of *A. rugosa* by a content rich in pulegone (60.8%) (Tab. 1.). The main property of this plant is to activate the immune system and to improve metabolism. The essential oil is able to decrease blood pressure and has bactericidal properties, and the presence of bioflavonoids suggests its use as an antioxidant agent [5].

***Agastache urticifolia* (Benth.) O. Kuntze (nettleleaf giant hyssop),** (Figure 1. c) is sometimes mentioned in literature as Laphanthus urticifolius and Agastache glaucifolia. Its native range includes western areas of North America, southern California and Colorado. It is a perennial plant, reaching 1.1-1.3 m in height; it starts blooming in August, being pollinated by bees. It is not very resistant to long periods with temperatures below -12 °C; it prefers south-facing, warm, sunny, well-drained soils. In our collection, the plants withstood well the last three winters. *A. urticifolia* can be propagated by seeds, sown directly in the soil in early spring and by seedlings obtained under indoor conditions, as well as by division carried out in spring and by young rooted basal cuttings. The plants are able to complete the full cycle of development in the first year of vegetation.

They start growing at the end of April. During summer, the plants are characterized by slow development, producing 1-2 stems bearing 4-6 pairs of first-order branches, 4-5 pairs of leaves with the length of the blade of 4.5-6.5 cm and width of 3-4 cm. The plants reach a height of 50-55 cm by the end of August. In September, the first buds appear, some reaching the beginning of the flowering stage. The growing season of *A. urticifolia* plants lasts 200-220 days. According to data from the literature, the essential oil content in the full flowering stage is 0.80-0.97% of the absolutely dry matter [6]. In our research, the maximum content was recorded in the full flowering stage, in 3-year-old plants and it was 0.45-0.49% in green mass and 1.10-1.15% in absolutely dry matter, respectively. The essential oil obtained by steam distillation from *Agastache urticifolia* plants is characterized by a high content of estragole (41.1%) and pulegone (20.4%) (Tab. 2). Estragole determines the strong antibacterial effect of the oil and its phytotoxic properties. Its presence gives the anise-like smell. Pulegone, gives the essential oil insecticidal properties, therefore, it can be recommended in the biological protection of plants.

Tab. 2. The chemical composition of the essential oil of Agastache urticifolia.

RT(min)	Kovats index	Compounds	Area %
6.91	973	Sabinene	0.1
6.97	976	3-Cyclohepten-1-one	0.7
7.19	985	3-Octanone	0.1
7.39	993	β-Myrcene	0.5
8.67	1030	Limonene	15.3
11.21	1101	Linalol	0.2
11.68	1113	1-Octenyl acetate	0.3
12.02	1122	1,3,8-ρ-Menthatriene	0.2
12.59	1136	cis-ρ-Mentha-2,8-dien-1-ol	0.2
13.37	1155	Menthone	1.7
13.80	1166	iso-Menthone	12.0
14.26	1178	cis-Linalool oxide (furanoid)	0.4
15.24	1202	Estragole	41.1
16.93	1241	Pulegone	20.4
23.85	1404	Methyl eugenol	5.1
24.56	1422	β-Caryophyllene	0.7
		Other compounds	1.0



GC-MS chromatogram of *Agastache urticifolia.*

***Agastache nepetoides* L.** (yellow giant hyssop), (Figure 1. d) is also known as Hyssopus nepetoides. It is native to Asia (China, Japan, Korea, Primorsky Krai of the Russian Federation, Taiwan, India and Vietnam), being a perennial species with tall and branched stems, oval-cordate opposite leaves, with coarsely toothed margins, 15 cm long, and whitish-yellow flowers, which start blooming in July. The calyx is 5-6 mm long, with five narrow triangular lobes. The petals are 8-10 mm long. The stamens are dynamic, long. The fruits are schizocarps, with 1.8 mm elliptical obovate mericarps. The flowers and leaves have a minty smell. *A. nepetoides* grows well on fertile soils with high humidity and exposed to a lot of sunlight. Under the climatic conditions of Moldova, it reaches 50-100 cm in height.

The aroma of plants is less strong if they grow in the shadow. *A. nepetoides* plants produce essential oil during the entire growing season, but its amount varies depending on the development stage. According to data from the literature, the largest amount of essential oil accumulates in the full flowering stage, namely, 1.05-1.18% of the absolutely dry matter [7]. The essential oil contains carvacrol, estragole, thymol, citral, nepetalic acid, nepetal-glucoside-ether, limonene, geraniol, caffeic acid, ursolic and rosmarinic acid [8].

The research confirms that the species of the genus *Agastache* are characterized by high adaptive potential, great vitality, regenerative capacity and fast growth. The plants are well adapted to the pedoclimatic and ecological conditions of our country and are of high value due to their chemical composition, being recommended for use in cosmetics and medicines.

Conclusions:

- The pedoclimatic conditions of the Republic of Moldova are favourable for the growth and development of *Agastache* species. Observations on the seasonal development peculiarities have proven that the species have a stable type of phenological development. They are able to complete the full ontogenetic cycle.
- The plants can be propagated by vegetative techniques – by division and generatively – by sowing directly in the field or by transplanting seedlings grown in the greenhouse.
- The essential oil of *A. rugosa* is characterized by a content rich in pulegone (60.8%). iso-menthone (16.9%) and limonene (12.3%), that of *A. urticifolia* is rich in estragole (41.1%), pulegone (20.4%), limonene (15.3%), iso-menthone (12%) and methyl-eugenol (5.1%). Due to its chemical composition, the essential oil possesses antimicrobial, anti-inflammatory and insecticidal properties.
- The species of the genus *Agastache* introduced and researched in the National Botanical Garden as aromatic and medicinal plants can serve as local sources of raw material for the production and diversification of the range of phytocosmetic and phytotherapeutic products.

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