

### III. INTRODUCTION OF PLANTS AND SUSTAINABLE USE OF PLANT RESOURCES

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## CONTRIBUTIONS TO THE MOBILIZATION, RESEARCH AND CAPITALIZATION OF MEDICINAL *LAMIACEAE* SPECIES IN THE BOTANICAL GARDEN (I) OF ASM

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**Abstract:** This paper presents updated data referring to the current state of medicinal *Lamiaceae* Lindl. species introduced and studied in the Botanical Garden (Institute) of ASM as well as the dynamics of taxa increase over the last decade. The list of new allochthonous *Lamiaceae* species introduced in the Botanical Garden (I) of ASM in 2005-2017 periods is given. The scientific data obtained add the information about biological peculiarities and chemical composition of promising *Lamiaceae* species growing in the Botanical Garden (I) of ASM, broadening the raw material base of medicinal plants by their introduction into cultivation.

**Key words:** medicinal plants, *Lamiaceae*, *ex situ* collection, mobilization, capitalization

### INTRODUCTION

The *Lamiaceae* Lindl. family (*Labiatae* Juss.) is the largest family of the order *Lamiales*, comprising about 220 genera and almost 4000 species spread all over the world, but mostly in the Mediterranean region and Southwestern Asia. [2, 14-16]. In the flora of the Republic of Moldova *Lamiaceae* family is represented by 28 genera and 82 species [19].

*Lamiaceae* family includes herbs, sometimes subshrubs or shrubs, annual or perennial, usually aromatic plants. Stems and branches are usually 4-angled. Leaves opposite, rarely whorled or alternate, simple to pinnately dissected or compound, without stipules. Inflorescences generally compound, sometimes flowers solitary and axillary; verticillasters 2- to many flowered, subtended by leaves or bracts. Flowers bisexual, zygomorphic, and bracteolate or not. Calyx persistent, 5-toothed, 2-lipped; upper lip 3-toothed or entire; lower lip 2- or 4-toothed. Corolla limb usually 2-lipped; upper lip 2-lobed and lower 3-lobed, rarely upper lip entire and lower 4-lobed, also rarely limb (4- or 5-lobed; tube hairy annulate inside. Stamens 4 or 2, free, rarely filaments connate, sometimes one staminodial; ovary superior, 2-carpellate but appearing equally 4-lobed when mature due to further partition; style single, usually branched above and gynobasic. Fruit usually 4 dry nutlets [15, 16].

The *Lamiaceae* is one of the most important plant families with extensive economic importance. The spectrum of their applications in the folk and modern medicine is wide. The majority of *Lamiaceae*, being aromatic plants are used in perfumery, cosmetics, and food industries as active ingredients or as flavour and fragrance. Many are cultivated as ornamentals but others are widely used as culinary herbs and spices. *Lamiaceae* species are used for medical purposes due to the presence of a large group of chemical compounds [21, 28] with antimicrobial, antifungal, antibacterial, anti-inflammatory and antioxidant activities [17, 18, 23, 28]. Nowadays, the utilization of medicinal plants in pharmaceutical industry is being extended annually by the introduction of new plant species, including *Lamiaceae* in the new formula of medical preparations.

In this context, the inventory, introduction, biological and phytochemical studies of *Lamiaceae* species from the collection of the Botanical Garden (Institute) of ASM, in order to increase therapeutic possibilities and their practical use in national economy was the main goal of this study. Introduction of medicinal *Lamiaceae* species involved the following steps: mobilization of gene pool; the study of the biological characteristics of plants and finding effective methods of cultivation; selection of the most productive individuals and populations; accumulation of seed and planting material; identification and research of promising medicinal plants for national economy.

## MATERIALS AND METHODS

The research was carried out during the years 2005-2017. The genetic resource mobilization of *Lamiaceae* medicinal species was achieved through international exchange of seeds (*Delectus Seminum*) and by collecting seeds and plant material from the indigenous flora during field expeditions. Studies for new plant species acclimatization were carried out in the Experimental subdivision of the Collection of Medicinal Plants (CMP). An extensive literature survey of studied species was made according to their therapeutic importance and utilization in ethno and modern medicine. Phenologic observations were performed annually during the entire vegetation period according to widely used methodological guidelines [24, 27, 29].

## RESULTS AND DISCUSSIONS

At present, in the Collection of Medicinal Plants from Botanical Garden (Institute) of ASM the *Lamiaceae* family is represented by 99 taxa belonging to 30 genera. A total of 76 taxa of medicinal *Lamiaceae* species introduced in the collection in 2005-2017 periods were obtained from the seeds received by *Delectus Seminum*. Another 23 species were brought from the spontaneous flora during the field expeditions (Fig. 1). Among the richest genera we can enumerate: *Salvia* with 11 taxa; *Nepeta* and *Thymus* with 9 taxa each and *Teucrium* with 7 species; three genera with 6 taxa (*Mentha*, *Hyssopus* and *Satureja*). Two genera (*Origanum* and *Lavandula*) include 4 taxa each, *Calamintha*, *Leonurus Dracocephalum* and *Scutellaria* are represented by 3 taxa. Ten genera (*Ajuga*, *Caryopteris*, *Galeobdolon*, *Leonotis*, *Majorana*, *Lamium*, *Melissa*, *Pycnanthemum*, *Prasium* and *Prunella*) are monospecific. Other seven genera (*Agastache*, *Clinopodium*, *Elscholtzia*, *Perilla*, *Rosmarinus*, *Phlomis*, and *Stachys*) are represented by 2 taxa (fig. 2).

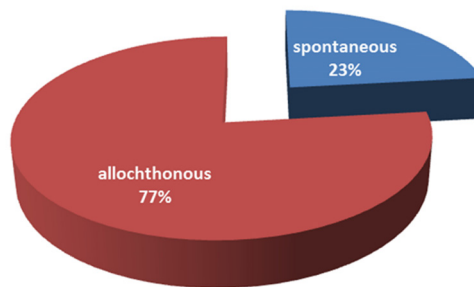


Fig. 1. The percentage of spontaneous and allochthonous species

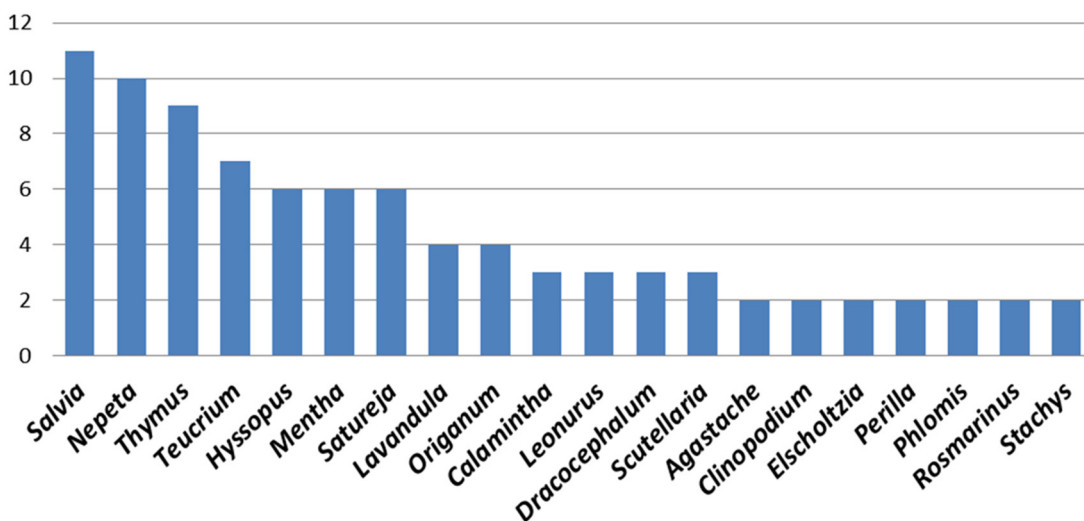


Fig. 2. The most representative genera

Only in 2011 the number of medicinal *Lamiaceae* plants introduced in the collection through international seed exchange increased with 8 species. In the same year 5 spontaneous *Lamiaceae* species were collected from the wild and transplanted in the collection (Fig. 3, Table 1).

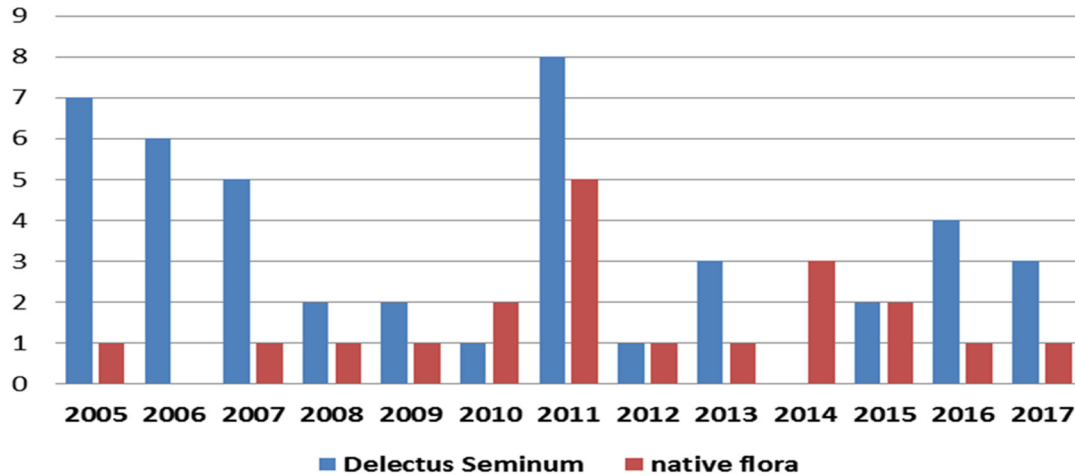


Fig. 3. Dynamics of presence of the number of *Lamiaceae* species (2005-2017 periods)

A number of new allochthonous *Lamiaceae* species (Table 1) included in the Medicinal plant collection underwent first introduction research in the conditions of Botanical Garden (I) of ASM.

Table 1.

**New allochthonous *Lamiaceae* species introduced in the Botanical Garden (I) of ASM in 2005-2017 periods**

Scientific name	Provenience		Therapeutic effects
	scientific institution	year	
<i>Lavandula latifolia</i> Medik.	BG, Padova, Italy	2005	expectorant, bactericidal, tonic, antifungal, cicatrizing
<i>Salvia tesquicola</i> Klok. et Pobed.	BG, Prague, Czech Republic	2005	aromatic, antioxidant, antimicrobial, antifungal, antiseptic
<i>Elsholtzia stauntonii</i> Benth.	BG, Leipzig, Austria	2005	antiviral, antibacterial, anti-inflammatory, antioxidant, myocardial ischemia protection
<i>Origanum tythanthum</i> Gontsch.	BG, Prague, Czech Republic	2005	antimicrobial, antibacterial, hypolipidemic, hypocholesterolemic
<i>Origanum virens</i> Link ex C. A. Mey.	BG, Stuttgart, Germany	2005	antimicrobial, antifungal, antioxidant, expectorant, anti-inflammatory
<i>Agastache rugosa</i> (Fisch. et C. A. Mey.) Kuntze	BG, Zurich, Switzerland	2005	antibacterial, anti-HIV integration activities, antioxidant, cardiovascular, cytoprotective

<i>Lavandula stoechas</i> L.	Museum of Natural History, Paris, France	2005	antibacterial, cytotoxic, antioxidant, antimicrobial, anticonvulsant, antispasmodic,
<i>Lavandula multifida</i> L.	BG, Basel, Switzerland	2006	antiseptic, anti-inflammatory, antifungal
<i>Scutellaria baicalensis</i> Georgi	BG, Lodz, Poland	2006	anti-inflammatory, tonic, anticancer, antispasmodic, expectorant, hemostatic
<i>Mentha gattefossei</i> Maire	BG, Coimbra, Portugal	2006	less studied for its applicability in phytotherapy
<i>Satureja montana</i> L. ssp. <i>illyrica</i> (Host.) Nym.	BG, Essen, Germany	2006	antioxidant, antibacterial, choleric, stimulant, digestive, antiseptic, antidiarrheal
<i>Nepeta camphorata</i> Boiss. et Heldr.	BG, Basel, Switzerland	2006	spasmolytic, febrifuge
<i>Origanum laevigatum</i> Boiss.	BG, Essen, Germany	2006	expectorant, antibacterial, antiseptic, diuretic
<i>Leonotis nepetifolia</i> (L.) R. Br.	Museum of Natural History, Paris, France	2007	psychoactive, relaxant, anthelmintic anti- convulsive, hypoglycemic, anti-diarrheic
<i>Leonurus sibiricus</i> L.	BG "Al. Borza", Cluj-Napoca, Romania	2007	antibacterial, cardiac, tonic, diuretic, hypnotic, stimulant, antispasmodic, depurative
<i>Satureja thymbra</i> L.	Museum of Natural History, Paris, France	2007	antibacterial, aromatic, digestive, expectorant, tonic
<i>Melissa officinalis</i> L. ssp. <i>altissima</i> (Smith) Arcang.	University of Medical Sciences, Poznan, Poland	2007	sedative, hemostatic, lactogenic, antibacterial, antifungal, antioxidant
<i>Hyssopus officinalis</i> L. ssp. <i>aristatus</i> (Godr.) Briq.	University of Medical Sciences, Poznan, Poland	2007	expectorant, anti-inflammatory, cicatrizing, anthelmintic
<i>Dracocephalum ruyschiana</i> L.	BG, Klagenfurt, Austria	2008	antimicrobial, antispasmodic, febrifuge, ophthalmic, wound healing
<i>Thymus comosus</i> Heuff. ex Griseb.	BG, Cluj Napoca, Romania	2008	antiseptic, expectorant, tonic, diuretic
<i>Agastache urticifolia</i> (Benth.) Kuntze	National BG of Belgium	2009	analgesic, stomachic, anti-rheumatic
<i>Pycnanthemum virginianum</i> (L.) T. Durand et B. D. Jacks.	BG, Essen, Germany	2009	analgesic, carminative, diaphoretic, febrifuge
<i>Prasium majus</i> L.	Museum of Natural History, Paris, France	2010	antioxidant, diuretic, anti-diarrheic
<i>Nepeta cataria</i> L. 'Citriodora'	BG, Graz, Austria	2011	sedative, antispasmodic, antioxidant, anti-inflammatory
<i>Salvia canariensis</i> L.	BG, Genoa, Italy	2011	expectorant, antimicrobial, cytostatic
<i>Salvia kopetdaghensis</i> Kudr.	BG, Klagenfurt, Austria	2011	spasmolytic, anti-inflammatory, cicatrizing

<i>Prunella vulgaris</i> L. var. <i>lilacina</i>	Tokyo Metropolitan Medicinal Plant Garden	2011	anti-inflammatory, antiseptic, diuretic, hemostatic, febrifuge
<i>Leonurus japonicas</i> Houtt.	Research Center for Medicinal Plant Resources, Ibaraki, Japan	2011	cardio protective, anti-oxidative, antimicrobial, neuroprotective and anti-cancer
<i>Hyssopus cretaceus</i> Dubjan.	Mountain BG of the Dagestan Scientific Center, Makhachkala	2011	expectorant, anti-inflammatory, cicatrizing, anthelmintic
<i>Hyssopus ambiguous</i> (Trautv.) Iljin	Mountain BG of the Dagestan Scientific Center, Makhachkala	2011	tonic, astringent, expectorant, anti-inflammatory,
<i>Calamintha foliosa</i> Opiz	Civico Orto Botanico di Trieste, Italy	2011	antibacterial, gastric, sedative
<i>Dracocephalum renati</i> Emb.	BG, Basel, Switzerland	2012	Cicatrizing, hemostatic, anti-inflammatory
<i>Perilla frutescens</i> (L.) Britt. var. <i>acuta</i>	Tokyo Metropolitan Medicinal Plant Garden	2013	antimicrobial, anti-inflammatory, anti-allergic, immuno-modulator, antioxidant and antitumor
<i>Nepeta grandiflora</i> Bieb.	BG, Targu Mures, Romania	2013	anti-inflammatory, spasmolytic, antidiarrheal
<i>Caryopteris incana</i> (Thumb. ex Houtt.)Miq.	BG, Graz, Austria	2013	antiseptic, anti-inflammatory, antimicrobial
<i>Thymus ellipticus</i> Opiz	BG, Targu Mures, Romania	2015	expectorant, antiseptic, spasmolytic, analgesic, anthelmintic
<i>Teucrium flavum</i> L.	BG, Munich , Germany	2015	antioxidant, antidiabetic, cardiovascular, analgesic
<i>Nepeta wilsonii</i> Duthie	BG, Vienna, Austria	2016	diuretic, antiseptic, antitussive, antispasmodic, expectorant
<i>Nepeta nuda</i> L. var. <i>albiflora</i> (Boiss.) Gams	BG, Vienna, Austria	2016	antispasmodic, expectorant, diuretic, antiseptic, antitussive, febrifuge
<i>Teucrium hircanicum</i> L.	Humboldt University, Berlin, Germany	2016	hypotensive, antitumor, haemostatic
<i>Dracocephalum argunense</i> Fisch. ex Link	BG, Stuttgart, Germany	2016	anti-allergic, cicatrizing, hemostatic, choleric
<i>Teucrium orientale</i> L.	BG, Munich , Germany	2017	bacteriostatic, spasmolytic, antioxidant and anti-inflammatory
<i>Teucrium botrys</i> L.	BG, Frankfurt, Germany	2017	cytotoxic, anti-anemic, cholagogue, febrifuge
<i>Clinopodium acinos</i> (L.) Kuntze	BG, Porrentruy, Switzerland	2017	antioxidant, antimicrobial, cicatrizing

BG – Botanical Garden

Further is presented the list of *Lamiaceae* medicinal plants introduced in the collection from spontaneous flora of Republic of Moldova (Table 2).

Table 2.

**Medicinal *Lamiaceae* species introduced in the Botanical Garden (I) of ASM from spontaneous flora of Republic of Moldova**

Scientific name	Place and date of sample collection		Therapeutic effects
	location, district	year	
<i>Scutellaria altissima</i> L.	Huliboaca, mun. Chişinău	2005	antitussive, hemostatic
<i>Teucrium chamaedrys</i> L.	Cricova, mun. Chişinău	2007	anti-inflammatory, antiseptic, decongestant
<i>Thymus marschallianus</i> Willd.	Maşcăuţi, Criuleni	2008	cicatrizing, expectorant, spasmolytic
<i>Phlomis pungens</i> L.	Zloţi, Cimişlia	2009	cicatrizing, immuno-stimulatory, sedative
<i>Origanum vulgare</i> L.	Hârtop, Floreşti	2010	cholagogue, anti-spastic, expectorant, antibacterial, antiseptic
<i>Betonica officinalis</i> L.	Rădenii Vechi, Ungheni	2010	hypotensive, anti-inflammatory, emetic, antibacterial, antifungal, expectorant
<i>Ajuga reptans</i> L.	Huliboaca, mun. Chişinău	2011	anti-inflammatory, cicatrizing, hemostatic, expectorant, diuretic, anti-spastic, anti-diarrheic
<i>Calamintha nepeta</i> (L.) Savi	Saharna, Rezina	2011	antibacterial, diuretic, gastric, sedative
<i>Salvia aethiopsis</i> L.	Făureşti, mun. Chişinău	2011	anti-inflammatory, cicatrizing, astringent
<i>Salvia nemorosa</i> L.	Hârtopul Mare, Criuleni	2011	cicatrizing, antibacterial, antimycotic
<i>Lamium album</i> L.	Saharna, Rezina	2011	hemostatic, expectorant, diuretic, cicatrizing, anti-inflammatory, depurative, cholagogue
<i>Phlomis tuberosa</i> L.	Huliboaca, mun. Chişinău	2012	tonic, hemostatic, antibacterial, antifungal, cicatrizing, antitumor
<i>Mentha verticillata</i> L.	Sărata Răzeşi, Leova	2013	diuretic, spasmolytic, hemostatic, antiseptic, sedative, analgesic, expectorant, antibacterial
<i>Nepeta cataria</i> L.	Mireşti, Nisporeni	2014	antispasmodic, expectorant, antitussive, astringent, carminative, appetizing, sedative
<i>Nepeta pannonica</i> L.	Zloţi, Cimişlia	2014	antispasmodic, febrifuge, tonic, antiseptic, anti-inflammatory, antimicrobial, antioxidant
<i>Nepeta parviflora</i> Bieb.	Bugeac, Comrat	2014	antioxidant, anti-inflammatory
<i>Teucrium polium</i> L.	Cricova, mun. Chişinău	2015	antibacterial, antioxidant, hemostatic
<i>Salvia pratensis</i> L.	Hârtopul Mare, Criuleni	2015	anti-inflammatory, antimicrobial
<i>Salvia verticillata</i> L.	Ciorescu, mun. Chişinău	2016	antibacterial, anti-diabetic, cytotoxic
<i>Galeobdolon luteum</i> Huds	Curchi, Orhei	2017	respiratory affections

For the introduction program, the research regarding plant biology features, ontogenetic cycle, growth and development in a new conditions during the vegetative period is very important. Thus, in recent years the research on biomorphological and ontogenetic peculiarities of the species of the genera: *Satureja* L., *Origanum* L., *Salvia* L., *Agastache* Clayton et Gronov., *Mentha* L., *Nepeta* L., *Perilla* L., *Lamium* L., *Teucrium* L. and *Thymus*

L. have been conducted.

Further is presented the description of some of the most valuable representatives of the *Lamiaceae* family introduced in the Botanical Garden (I) of ASM in 2005-2017 periods.

Genus *Ajuga* L. – Bugleweed (Vinețică). Two *Ajuga* species (*Ajuga reptans* L. (fig. 4) and *A. genevensis* L.) cultivated in *ex situ* undergo a complete ontogenetic cycle, passing consecutively all life periods. The phytochemical analysis highlighted a high content of flavonoids, hydroxycinnamic acids and total polyphenols in the methanol extract of *A. reptans* and *A. genevensis*. The etanolic extracts showed an evident antioxidant activity due to higher concentrations of flavonoids and hydroxycinnamic acids [11].

Genus *Mentha* L. – Mint (Mintă). The genus includes the important group of medicinal, aromatic and culinary herbs. The spectrum of their applications in the folk and modern medicine is wide. In the context of the optimal growth characteristics and phytochemical profile promising results were obtained for *Mentha gattefossei* Maire, an endangered species, listed in the IUCN Red List of threatened species [20]. In the climatic and soil conditions of the Republic of Moldova the plants undergo a complete ontogenetic cycle, which demonstrates high adaptive potential and *ex-situ* conservation perspective [8]. The volatile oil of *M. gattefossei* cultivated in Moldova is characterized by the predominance of oxygenated monoterpenes and belongs to chemotype pulegone/menthone, thus demonstrating antioxidant activity [1].

Genus *Nepeta* L. – Catnip (Cătușnică). Within the nine *Nepeta* L. species growing in the collection, our study was focused on three species (*Nepeta cataria* L., *N. pannonica* L. and *N. parviflora* Bieb.) [7]. Is to be mentioned that *N. parviflora*, species threatened with extinction in the local flora (included in the Red Book of the Republic of Moldova, 3<sup>rd</sup> edition [22] is rich in phenolic compounds with high antioxidant activity [26].

Thus, introduction into culture has potential both for its capitalization and conservation.

Genus *Origanum* L. – Oregano (Sovârv). The comprehensive biological and phytochemical studies on the species of the genus *Origanum* L. (*Origanum vulgare* L., *O. onites* L., *O. hirtum* Link, *Origanum tythanthum* Gontsch., *O. laevigatum* Boiss.) grown in herb collection were undertaken. Investigated species are important sources of essential oils, containing increased amounts of thymol and carvacrol, requested these days in the pharmaceutical and food industries [3].

Genus *Perilla* L. – Perilla (Susan sălbatic). Our research refers to the study of *Perilla frutescens* (L.) Britt. var. *purpurascens* (Hayata) H. W. Li which nowadays is cultivated in many European and North American countries for medicinal, culinary and ornamental uses. In climatic and soil conditions specific to Republic of Moldova the plants pass consecutively all phenological phases starting from the seed sowing to the seed setting and senile stages. The phytochemical analysis highlighted the rosmarinic acid as the main compound in all analyzed samples. The optimal harvest period is month July when content in polyphenolic compounds is at highest level [9].

Genus *Satureja* L. – Savory (Cimbru). Six species of the genus *Satureja* L. (*Satureja montana* L., *S. kitaibelii* Wierzb., *S. parnassica* Heldr. et. Sart ex. Boiss., *S. thymbra* L., *S. subspicata* Bartl. ex. Vis. (fig. 5), *S. montana* ssp. *illyrica* (Host.) Nym.) were included in the research agenda. The investigation results showed that the species *S. montana*, *S. kitaibelii*, *S. subspicata* and *S. parnassica* are medicinal plants with promising therapeutic effect which grow and develop normally in the climatic conditions of Republic of Moldova, completing the entire



Fig. 4. *Ajuga reptans*

ontogenetic cycle [5]. High content of carvacrol registered in *S. montana* attribute to the plants antimicrobial, antimycotic and antifungal qualities, representing an important source of raw materials for the pharmaceutical industry [4]. Results of the analysis regarding the content and chemical composition of *S. subspicata* essential oil, argues also, of important therapeutic value of this plants. The *S. subspicata* essential oil consists mostly of phenolic monoterpenes, monoterpene hydrocarbons, bicyclic sesquiterpenes and their oxygenated derivatives. The most abundant components are phenolic terpene carvacrol, monoterpene hydrocarbons *p*-cimen and  $\gamma$ -terpinene. Unreported before components like  $\gamma$ -terpinene, (*E*)- and (*Z*)-citral,  $\beta$ -bisabolene, nerol,  $\beta$ -caryophyllene in the essential oil may increase the biological activity and perfumery value of *S. subspicata* oil of Moldovan origin [12].



Fig. 5. *Satureja subspicata*



Fig. 6. *Teucrium hircanicum*

antioxidant activity was shown by two chemotypes of *Thymus marshallianus* Willd. species from spontaneous flora and *ex situ* experiments which have high polyphenolic content and volatile fraction rich in *o*-cymene,  $\gamma$ -terpinen and trans-citral [13].

Thus, the results of a long-term study of plants of the *Lamiaceae* family indicate the prospects of introduction of representatives of this family in the conditions of Republic of Moldova. According to assessment of introduction capabilities, 62 species are highly stable, 28 species – stable and 9 species are unstable. The vast majority of *Lamiaceae* species introduced in the collection of medicinal plants are successfully cultivated being highly adapted to local edaphic and climatic conditions. They pass all the stages of seasonal development, show good indicators of seed reproduction giving a viable self-seeding. The results of this research made possible to identify promising species for extensive cultivation and further implementation in pharmaceutical, food and cosmetic industries.

Genus *Teucrium* L. – Germander (Jugărel) represents mostly perennial herbs, shrubs or subshrubs. Modern pharmacological studies suggest that some *Teucrium* L. species are found to be rich natural sources of new bioactive substances with antimicrobial, antioxidant and antifungal activities [25]. In our study an intensive vegetative growth with abundant flowering under *ex situ* conditions was observed for *Teucrium hircanicum* L. (fig. 6) and *Teucrium polium* L. It was also revealed that under the conditions of cultivation the rhythm of seasonal development of spontaneous *T. polium* is generally the same as in natural habitat [6]. The main components of the *T. polium* essential oil are Germacrene D,  $\beta$ -pinene,  $\alpha$ -pinene and bicyclogermacren. The *T. polium* essential oil belonging to Germacrene D chemotype represents an important source with potential application as an antimicrobial agent in the treatment of various diseases.

Genus *Thymus* L. – Thyme (Cimbru). *Thymus* species are important medicinal herbs, rich in various active substances such as carvacrol, thymol, *p*-cymene and terpinene with strong spasmolytic, antibacterial and antioxidant activities [10]. As a result of our studies, the high



## CONCLUSIONS

In the period 2005-2017 by means of international seed exchange the collection was enriched with 76 *Lamiaceae* species, forms and varieties received by *Delectus Seminum* and 23 introduced from spontaneous flora. The comprehensive biological and phytochemical results have been obtained on species of the following genera: *Satureja* L., *Origanum* L., *Salvia* L., *Agastache* Clayt. et Gronov., *Mentha* L., *Nepeta* L., *Perilla* L., *Lamium* L., *Teucrium* L. and *Thymus* L. demonstrating their potential for introduction into crop growing. The available literature and the results obtained showed that most of bioactivities and medicinal properties of these species could be attributed to their essential oils, known to have applications in the food, pharmaceutical and cosmetic industries.

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