

BIOECOLOGICAL EVALUATION OF SOME NEWLY INTRODUCED SALVIA L. SPECIES IN THE COLLECTIONS OF THE BOTANICAL GARDEN

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The conservation of biodiversity and the rational use of natural resources represent major challenges of contemporary society. The increasing anthropogenic pressure on ecosystems – such as deforestation, pollution and overexploitation – contributes to the decline of biological diversity and the accelerated degradation of the environment.

Biodiversity conservation requires not only the strict protection of species and habitats, but also the responsible use of natural resources, so that they can be transmitted to future generations in optimal condition. The integration of scientific research with effective environmental management and protection measures is essential for ensuring the long-term stability of biological resources and the ecosystemic balance.

A core activity of botanical gardens is the introduction of plant species from the native spontaneous flora, as well as from other geographic regions. This process aims, on the one hand, to enrich the regional flora with new economically valuable species and, on the other hand, to promote the complex and rational use of phylogenetic resources [1].

The collections of living or preserved plants maintained by the Botanical Garden play an essential role in preventing species extinction, in preserving genetic diversity and in promoting the sustainable use of plant resources. Among these, the collection of aromatic plants is of particular importance, comprising approximately 200 species. This collection includes a diverse range of taxa belonging to different botanical families, with annual, biennial or perennial life cycles. This collection encompasses a diverse range of taxa belonging to various botanical families and exhibiting annual, biennial, or perennial life cycles. The species included are distinguished by their high content of essential oils and/or by characteristic organoleptic properties, such as specific aromas and taste.

Aromatic plants are of particular interest due to their wide range of applications in aromatherapy, phytotherapy, gastronomy, as well as the cosmetic and food industries, being used throughout the year, both fresh and dried.

A fundamental task of the research program on aromatic plants is the introduction and acclimatization of species originating from different phytogeographical

regions, whose ecological requirements are compatible with the local pedoclimatic conditions, allowing their optimal development and the accumulation of biologically active compounds, particularly essential oils. Within this research framework, special attention was given to representatives of the family Lamiaceae Lindl., with the present study focusing on species of the genus *Salvia* L.

The genus *Salvia* L. is one of the most numerous in the plant kingdom, comprising approximately 1000 species, belonging to the subfamily Nepetoideae Kostel., family Lamiaceae. Sage species are widely distributed across temperate, subtropical and tropical regions worldwide. The greatest diversity is found in Central and South America, with more than 500 species, followed by Central Asia and the Mediterranean region, with over 250 species, and East Asia, with over 90 species [2].

Salvia L. is a highly diverse genus, which includes species used worldwide in classical and traditional medicine, as well as in ritual practices. In addition to their ethno-medicinal uses, *Salvia* species also possess significant ornamental and culinary value, highlighting their broad ethnobotanical relevance. The genus *Salvia* L. includes annual, biennial or perennial species, typically reaching 50-100 cm in height, with erect or ascending stems. The leaves are entire, petiolate, pinnatisect, opposite, with a crenate or serrate margin. The flowers are asymmetrical, bisexual, short-pedunculate, arranged in terminal inflorescences; they are bilabiate, with an upper lip forming a helmet-like structure and a lower lip trilobed, with a larger median lobe. The corolla exhibits a range of colours, including blue-violet, red, pink, yellow and white. Most species are rich in essential oils and are valued for their medicinal, dye-producing, ornamental and melliferous properties [2].

Many *Salvia* species are characterized by the presence of trichomes on leaves, stems and flowers, which contribute to reducing water loss in certain taxa. In some species, the trichomes are glandular and produce essential oils that confer a characteristic aroma to the plant. In the flora of Bessarabia, eight *Salvia* species are recorded, including: *Salvia aethiopis* L., a relatively rare species characterised by whitish, tomentose leaves and white to pale yellow flowers, occurring in xeric habitats and hilly areas; *Salvia glutinosa* L., a species occurring in humid forest environments, characterized by large, sticky leaves and pale yellow flowers; *Salvia pratensis* L., a common meadow and forest-edge species valued for its blue-violet corollas; *Salvia verticillata* L., a perennial species growing in grasslands and roadsides with pale purple flowers arranged in verticillasters; *Salvia nemorosa* L. – typically occurs in drier habitats such as grasslands and forest clearings, bearing purple to violet flowers; *Salvia austriaca* L., a steppe species with pale yellow flowers, often found in grasslands and cultivated areas; and *Salvia dumetorum* Andrz., a perennial herb adapted to steppe and dry meadow conditions, notable for its ornamental value and drought tolerance.

Over the years, within the Collection of Aromatic Plants, 16 *Salvia* taxa have been introduced through international seed exchange, including species from both the local spontaneous flora and other geographic regions, namely: *Salvia aethiopis*

L., *Salvia farinacea* ‘Victoria Blue’, *Salvia bucharica* Popov, *Salvia candelabrum* Boiss., *Salvia verbenaca* L., *Salvia deserta* Schangin, *Salvia dolomitica* Codd., *Salvia forskahlei* L., *Salvia fruticosa* Mill., *Salvia glutinosa* L., *Salvia grandiflora* Ettling., *Salvia officinalis* L., *Salvia officinalis* subsp. *lavandulifolia* (Vahl), *Salvia officinalis* ‘Tricolor’, *Salvia tesquicola* Klokov & Pobed. and *Salvia viridis* ‘Tricolor’. These taxa were introduced, monitored and researched under the pedoclimatic conditions of the Republic of Moldova with respect to their growth and developmental biomorphological traits. In addition, their essential oil content was assessed to identify taxa of aromatic, medicinal and culinary interest. All species succeeded to complete their full ontogenetic cycle and produced viable seeds by the end of the growing season.

Of particular interest is *Salvia fruticosa* Mill. (Greek sage), a species valued for its ornamental attributes, medicinal properties, culinary applications and high melliferous potential. The initial plant material was obtained through international seed exchange from Italy. *Salvia fruticosa* is native to the eastern Mediterranean region, southern Europe, including southern areas of France, North Africa and the Canary Islands. It is particularly abundant in Palestine, Israel and Lebanon. Under the pedoclimatic conditions of the Republic of Moldova, *S. fruticosa* plants reach approximately 0.5 m in height, with flowering stems extending 25-30 cm above the foliage. The whole plant is covered with hairs and the leaves vary in size and are densely arranged, conferring a distinctive silvery-grey and bushy appearance to the plant. The flowers are lavender-pink, approximately 1.2 cm long, and are arranged in verticillasters along the inflorescence axis. Each flower is subtended by a small pubescent calyx. The essential oil content varies between 0.5 and 1.5% of the absolute dry matter under local cultivation conditions. The highest concentrations are recorded during the full flowering stage, particularly in the leaves, where values may reach 1.8-2.0%. The species is a hermaphroditic, evergreen subshrub, well-known for attracting a wide range of pollinators. It performs best in full sun and is well adapted to light, well-drained and relatively dry soils. It is characterized by high drought tolerance. The leaves of *S. fruticosa* may be harvested throughout the growing season, although their aroma is typically most intense from spring to early summer, at the beginning of the flowering stage. Flowering generally occurs from late May to early June. *S. fruticosa* is a moderately fast-growing species and may reach reproductive maturity during its first growing season when cultivated under optimal conditions. Numerous studies investigating the chemical composition of its essential oil have mentioned eucalyptol (1,8-cineole) and camphor as the predominant constituents. Additional phytochemical investigations are needed to comprehensively evaluate the potential of this species. Due to the astringent substances present in its essential oils, the plant is reported to help regulate excessive sweating and support gum health. The plant possesses a strong, camphor-like aroma and may be used as a culinary spice. Besides, *S. fruticosa* is a species with high melliferous potential. Its nectar-rich flowers are intensively visited by bees and other pollinators, supporting local biodiversity. Being native to

the Mediterranean Basin, it is well adapted to dry environments and may contribute to soil stabilization in arid areas.

Another species introduced and studied in the collection since 2020 is *Salvia verbenaca* L., a perennial plant that reaches a height of 30-40 cm under the local conditions. The plant is aromatic, more or less glandular and pubescent in the upper parts. Its slightly branched stems bear clusters of dark blue flowers, of high ornamental value. The leaves are oblong, 2-3 cm wide, crenulate or deeply lobed, with the upper leaves being sessile. The flowers are relatively small, pale blue to whitish, arranged in short inflorescences. The content of essential oil was determined in all the aerial part of the plant and was found to be relatively low, ranging from 0.09% to 0.12% of the absolutely dry matter. Ethnobotanical investigations of *S. verbenaca* have revealed its wide use in traditional medicine for the treatment of various digestive disorders and abdominal colic [4]. Some studies claimed that *S. verbenaca* may possess anticancer properties, due to its major constituents, including carvacrol, limonene and thymol [5]. *S. verbenaca* is considered a promising species due to its drought tolerance and the presence of bioactive compounds with potential applications in the pharmaceutical and cosmetic industries.

Salvia farinacea 'Victoria Blue' (also known by the common name mealycup sage) is characterized by relatively low essential oil content (0.1-0.3%) compared with other *Salvia* species, however, it possesses exceptional ornamental value. It is a perennial subshrub that reaches 65-80 cm in height under local conditions. The plant bears grey-green, irregularly serrated, ovate-lanceolate leaves and dense, highly branched, violet-blue spikes-like inflorescences, somewhat resembling those of lavender. Flowering continues until late summer. This species *S. farinacea* is native to Mexico and the south-western regions of the United States, and is cultivated primarily as an aromatic and ornamental plant due to its dense blue-violet inflorescences. Its erect stems and inflorescences are suitable for use as cut flowers. The flowers attract bees and butterflies over an extended flowering period of approximately 45-55 days. According to data reported in the literature, the essential oil of this species is rich in terpenes and terpenoid compounds. The main bioactive constituents identified include camphor, α -pinene, β -pinene, 1,8-cineole (eucalyptol) and D-germacrene. Pharmacological studies have indicated that extracts of *S. farinacea* contain polyphenolic compounds and exhibit antioxidant activity [6]. Despite these findings, the species remains relatively understudied and would benefit from further investigation.

Salvia officinalis subsp. *lavandulifolia* (Vahl) was introduced into the Botanical Garden in 2021, through the international seed exchange programme (*Delectus Seminum*), from the Botanical Garden of Târgu Mureș, Romania. Commonly known as the lavender-leaved sage, *S. officinalis* subsp. *lavandulifolia* is a perennial, semi-woody species native to Spain and southern France. Under the local pedoclimatic conditions, plants reach up to 35 cm in height and are characterized by a spreading habit and evergreen, narrow lanceolate leaves of greyish-white colour, generally

reaching less than 50 mm in length. The leaves are arranged oppositely along the stem and appear clustered. When crushed, they release a rosemary-like aroma associated with the essential oil. This oil is used in the fragrance industry, including in the manufacture of soaps, detergents and toothpaste. The flowers are of pale lavender colour, approximately 25 mm long, borne on short inflorescences. The full flowering stage starts in early June and lasts for 35-40 days. The essential oil content varies according to climatic conditions, plant age and developmental stage. Under the conditions of the Republic of Moldova, three-year-old plants contain 1.2-1.6% essential oil on a dry matter basis at the end of the flowering period. According to literature data, the essential oil content may reach 4.0%. The major constituents of the essential oil of *S. officinalis* subsp. *lavandulifolia* are 1,8-cineole and camphor, followed by camphene and α -pinene [7]. The essential oil has been reported to possess tonic, antiseptic and calming properties. Due to its fresh, slightly camphoraceous aroma, it is widely used in aromatherapy, being appreciated for its invigorating effects, which may contribute to improving memory and mental focus. It has also been associated with applications related to skin care, respiratory well-being and emotional balance. *S. officinalis* subsp. *lavandulifolia* represents a promising species for further study in phytomedicine and aromatherapy due to the distinctive chemical composition of its essential oil. Under the local conditions, the species demonstrates good adaptation potential and drought tolerance, completes its full developmental cycle, produces viable seeds and accumulates high levels of essential oil. These characteristics suggest its potential suitability for cultivation on a larger scale as an aromatic, medicinal and melliferous crop.

Overall, the *Salvia* L. species introduced and investigated in the Aromatic Plant Collection of the Botanical Garden exhibit diverse ornamental, melliferous, aromatic and phytochemical characteristics. All studied species successfully completed their ontogenetic cycle under the pedoclimatic conditions of the Republic of Moldova and produced viable seeds at the end of the growing season, indicating a good capacity for adaptation and acclimatization. The phytochemical evaluation revealed significant interspecific variation in essential oil content, depending on both species and plant organ. Among the studied taxa, *Salvia fruticosa* Mill. (0.5-1.5% essential oil, reaching a maximum of 1.8-2.0% in leaves at full flowering) and *Salvia officinalis* subsp. *lavandulifolia* (Vahl) (1.2-1.6% essential oil in three-year-old plants) were characterized by comparatively high essential oil contents with increased concentrations of bioactive constituents (eucalyptol, camphor etc.). In contrast, *Salvia farinacea* 'Victoria Blue' (0.1-0.3%) and *Salvia verbenaca* L. (0.09-0.12%) exhibited lower essential oil content, but were distinguished by their higher ornamental value and drought tolerance. The multidisciplinary investigations conducted on species introduced through international seed exchange programmes highlight the importance of applied research in the identification and evaluation of plant resources and their potential applications under local cultivation conditions. Continued studies are necessary to provide a scientific base for the sustainable

production of raw plant material with potential economic value. The establishment into cultivation and industrial application of species demonstrating favourable adaptive traits and satisfactory essential oil productivity, such as *S. officinalis* subsp. *lavandulifolia* and *S. fruticosa*, may provide opportunities for the development of commercial plantations. Such initiatives could contribute to the diversification of locally produced plant raw materials and may help reduce harvesting pressure on natural populations, thereby supporting biodiversity conservation.

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BIBLIOGRAPHY

1. Diversitatea plantelor în contextul strategiei europene de conservare a biodiversității. coordonator Anca Sârbu. București, Alo, 2001, 320 p.
2. Walker, J.B., Sytsma, K.J., Treutlein, J., Wink, M., Salvia (Lamiaceae) is not monophyletic: implications for the systematics, radiation, and ecological specializations of Salvia and tribe Mentheae. Am. J. Bot. 91, 2004, 1115–1125. <https://doi.org/10.3732/ajb.91.7.1115>.
3. Flora Basarabiei Vol. (Plantele superioare spontane), Chișinău, Universul, 2022, 543 p. ISBN 978-9975-47-235-7
4. Canzoneri M., Bruno M., Rosselli S., et al. Chemical composition and biological activity of Salvia verbenaca essential oil. Natural Product Communications. 2011, 6(7, article 1934578X1100600) doi: 10.1177/1934578x1100600725. [DOI] [PubMed] [Google Scholar]
5. Islam M. T., Khalipha A. B. R., Bagchi R., et al. Anticancer activity of thymol: a literature-based review and docking study with emphasis on its anticancer mechanisms. IUBMB Life . 2019, 71(1):9–19. doi: 10.1002/iub. 1935. [DOI] [PubMed] [Google Scholar]
6. Andrea F Afonso et.al., The Health-Benefits and Phytochemical Profile of *Salvia apiana* and *Salvia farinacea* var. *Victoria Blue*. Antioxidants. Decoctions 2019, 8(8):241. doi: 10.3390/antiox8080241
7. Noura S. Dosoky, Ambika Poudel. Volatile Composition and Enantiomeric Distribution of Spanish Sage (*Salvia officinalis* Subsp. *lavandulifolia* [Vahl] Gams) From Spain. Saje Jurnals, 2022 <https://doi.org/10.1177/1934578X221139402>