

Article

Exploratory Analytical Characterization of Phenolic Profiles and Antioxidant Activity in Three Lavender Genotypes

Mihaela Bogdan ^{1,†}, Mihai Octavian Botea ^{2,†}, Manuela Bianca Pașca ^{1,*} , Mirela Delia Țiț ^{1,3,*} ,
Anamaria Lavinia Purza ¹, Tiberiu Sebastian Nemeth ^{1,3} , Manuel Alexandru Gîtea ⁴, Gabriela S. Bungau ^{1,3}
and Daniela Gîtea ^{1,3}

¹ Department of Pharmacy, Faculty of Medicine and Pharmacy, University of Oradea, 410028 Oradea, Romania; mbogdan@uoradea.ro (M.B.); lpurza@uoradea.ro (A.L.P.); snemeth@uoradea.ro (T.S.N.); gbungau@uoradea.ro (G.S.B.); dgitea@uoradea.ro (D.G.)

² Department of Surgical Disciplines, Faculty of Medicine and Pharmacy, University of Oradea, 410073 Oradea, Romania; m.botea@uoradea.ro

³ Doctoral School of Biomedical Sciences, University of Oradea, 410073 Oradea, Romania

⁴ Department of Agriculture and Horticulture, Faculty of Environmental Protection, University of Oradea, 410048 Oradea, Romania; mgitea@uoradea.ro

* Correspondence: bpasca@uoradea.ro (M.B.P.); dtit@uoradea.ro (M.D.Ț.)

† These authors contributed equally to this work.

Abstract

This exploratory study investigated the phenolic composition and antioxidant activity of dried inflorescence extracts prepared from three commercially cultivated lavender materials: *Lavandula angustifolia* ‘Moldoveanca 4’, *Lavandula angustifolia* ‘Sevtopolis’, and *Lavandula* × *intermedia* ‘George 90’. Using HPLC-DAD-ESI⁺ analysis, fourteen phenolic compounds predominantly belonging to the hydroxybenzoic acid, hydroxycinnamic acid, and flavone classes were tentatively annotated, and their levels were estimated as class-equivalent concentrations. Descriptive quantitative differences were observed among the three extracts for all fourteen compounds. The chromatographic sum of their class-equivalent concentrations showed the highest value in ‘Sevtopolis’ (1064.44 ± 1.03 µg/mL), followed by ‘George 90’ (924.03 ± 1.13 µg/mL) and ‘Moldoveanca 4’ (825.87 ± 2.3 µg/mL). The ‘Sevtopolis’ extract also showed the highest DPPH radical-scavenging activity, followed by ‘George 90’ and ‘Moldoveanca 4’. Taken together, these findings provide a preliminary analytical characterization of three specific lavender extracts and describe sample-specific phenolic and DPPH patterns under the conditions employed, without supporting genotype-level inference.

Keywords: *Lavandula angustifolia*; *Lavandula* × *intermedia*; phenolic compounds; antioxidant activity; HPLC-DAD-ESI⁺; DPPH; class-equivalent quantification; exploratory analysis



Academic Editor: Antonios E. Koutelidakis

Received: 9 July 2026

Revised: 1 August 2026

Accepted: 4 August 2026

Published: 6 August 2026

Copyright: © 2026 by the authors.

Licensee MDPI, Basel, Switzerland.

This article is an open access article distributed under the terms and conditions of the [Creative Commons Attribution \(CC BY\)](https://creativecommons.org/licenses/by/4.0/) license.

1. Introduction

For millennia, plants have been recognized and used for their therapeutic effects in the treatment of various diseases [1]. In this context, the *Lamiaceae* family comprises numerous aromatic and medicinal plants of considerable scientific, industrial, and commercial importance. Within this family, the genus *Lavandula* is particularly valued for its extensive use in perfumery, cosmetics, phytotherapy, aromatherapy, and, increasingly, in food and nutraceutical applications. Native primarily to the Mediterranean region, the genus includes more than 40 species together with numerous subspecies, hybrids, and cultivated forms, reflecting substantial botanical and phytochemical diversity [2–5]. Among

the most economically important taxa, *Lavandula angustifolia* Mill. (true lavender) is widely cultivated because of its adaptability, high-quality essential oil, and recognized value as a source of bioactive compounds. In addition to true lavender, *Lavandula* $\times$ *intermedia* Emeric ex Loisel. (lavandin), a natural hybrid derived from *Lavandula angustifolia* and *Lavandula latifolia* Medik., is of considerable agronomic importance due to its vigorous growth, high biomass production, and distinctive phytochemical characteristics.

Although lavender has traditionally been investigated for its essential oil composition, particularly its volatile terpenoid constituents responsible for fragrance and many of its traditional applications, increasing attention has recently been directed toward the non-volatile fraction of the plant. Lavender extracts contain a wide range of phenolic compounds, including hydroxybenzoic acids, hydroxycinnamic acids, flavonoids, and flavones, which contribute to antioxidant, anti-inflammatory, and antimicrobial activities [3,6]. Consequently, lavender is increasingly regarded not only as an aromatic crop but also as a valuable source of phytochemically active molecules with potential applications in the pharmaceutical, nutraceutical, cosmetic, and food industries.

The phenolic composition of lavender is influenced by multiple factors, including species identity, genetic background, cultivar, geographical origin, environmental conditions, cultivation practices, developmental stage, harvest period, plant organ, and extraction methodology [5–7]. As a result, considerable quantitative and qualitative variability may occur among lavender genotypes. Such variability is of particular interest because differences in phenolic composition may affect both the biological activity and the potential industrial value of lavender-derived products. Previous studies have demonstrated cultivar-dependent variation in phenolic accumulation and have highlighted the potential of phenolic compounds as markers for phytochemical differentiation among lavender taxa [5,8]. Similarly, comparative studies on the essential oil fraction of Romanian *Lavandula angustifolia* varieties have shown that genotype and year of cultivation significantly influence the chemical composition and biological activity of the plants, further supporting the relevance of genotype-driven variability across both volatile and non-volatile fractions [9,10].

The investigated plant material comprised commercially relevant Eastern European lavender germplasm from two distinct taxonomic groups, cultivated and harvested from the same plantation despite the different geographical origins of the genotypes. ‘Moldoveanca 4’ and ‘Sevtopolis’ are cultivars of *Lavandula angustifolia* Mill., whereas ‘George 90’ is a genotype of *Lavandula* $\times$ *intermedia* Emeric ex Loisel. The investigated genotypes originate from different breeding programs and geographic regions, namely the Republic of Moldova, Bulgaria, and Romania, respectively [2,3,11]. ‘Moldoveanca 4’ in particular has been previously characterized in Romanian-grown material with respect to its essential oil composition and antioxidant and antimicrobial potential [9,10]. This distinction is particularly relevant because hybridization and genetic background may influence the biosynthesis and accumulation of secondary metabolites, potentially resulting in genotype-specific phytochemical profiles.

Despite the extensive literature on lavender, most studies have focused on essential oil characterization, whereas detailed investigations of phenolic composition remain comparatively less common. Studies integrating chromatographic phenolic profiling with antioxidant assessment in commercially cultivated Eastern European lavender materials are particularly limited. This is especially the case for ‘Moldoveanca 4’, ‘Sevtopolis’, and ‘George 90’. Therefore, an exploratory characterization of these materials may expand the available phytochemical information and provide a basis for future investigations using independent biological replicates and controlled cultivation conditions [12].

In this context, the present exploratory study aims to characterize and descriptively compare the phenolic profiles of three commercially cultivated lavender materials using HPLC-DAD-ESI⁺ analysis. A further objective is to determine the DPPH radical-scavenging activity of the extracts as a complementary assessment of their *in vitro* antioxidant properties. By integrating chromatographic profiling with descriptive data analysis, the study aims to provide a preliminary analytical characterization of three specific lavender extracts obtained from Eastern European cultivars. The observed differences are interpreted as sample-specific analytical patterns rather than evidence of genotype-dependent variation.

2. Results

2.1. Compound Identification and Quantification

Fourteen phenolic compounds were tentatively annotated, and their levels were estimated as class-equivalent concentrations, in the HPLC-DAD-ESI⁺ chromatograms of the three lavender extracts analyzed (Table 1). The tentatively annotated compounds belonged mainly to the hydroxybenzoic acid, hydroxycinnamic acid, and flavone classes.

Table 1. Chromatographic and spectral characteristics of the phenolic compounds.

Peak No.	R _t (min)	UV λ _{max} (nm)	Observed Ions (m/z)	Phenolic Compound
1	3.13	270	139	2-Hydroxybenzoic acid
2	12.18	270	317	2,4-Dihydroxybenzoic acid-glucoside
3	13.36	312	371, 195	Ferulic acid-glucuronide
4	14.37	280	345	Vanillic acid-glucuronide
5	15.43	322	357, 195	Ferulic acid-glucoside
6	16.09	350, 250	611, 287	Luteolin-diglucoside
7	16.65	350, 250	463, 287	Luteolin-glucuronide
8	17.41	340, 270	433, 271	Apigenin-glucoside
9	17.82	340, 270	447, 271	Apigenin-glucuronide
10	19.40	329	361	Rosmarinic acid
11	21.14	350, 250	287	Luteolin
12	22.57	320	179	4-Methoxycinnamic acid
13	22.99	340, 270	271	Apigenin
14	24.02	340, 280	315	5,6-Dihydroxy-7,8-dimethoxyflavone

Note: R_t, retention time; λ_{max}, wavelength of maximum absorbance; [M + H]⁺, protonated molecular ion. Observed ions include [M + H]⁺ ions and, where applicable, additional fragment ions.

Chromatographic profiles recorded at 280 nm and 340 nm showed well-resolved peaks corresponding to the compounds listed in Table 1 (Figure 1). Detection at 280 nm provided higher signal intensity for most phenolic compounds, while chromatograms recorded at 340 nm better highlighted flavone derivatives, particularly luteolin- and apigenin-based compounds. The retention time pattern was consistent across the investigated extracts, while differences in peak intensities were observed, especially in the 12–16 min region, suggesting compositional differences among the analyzed extracts.

The class-equivalent concentrations of the phenolic compounds tentatively annotated showed descriptive differences among the three lavender extracts (Table 2). These sample-specific differences were observed both for individual compounds and within the main phenolic subclasses, especially hydroxybenzoic and hydroxycinnamic acid derivatives. The compounds showing the highest estimated levels were 2,4-dihydroxybenzoic acid-glucoside, vanillic acid-glucuronide, and 4-methoxycinnamic acid, although their levels varied among the analyzed extracts. The results were evaluated descriptively, without inferential statistical testing, and should not be interpreted as evidence of genotype-dependent accumulation patterns.

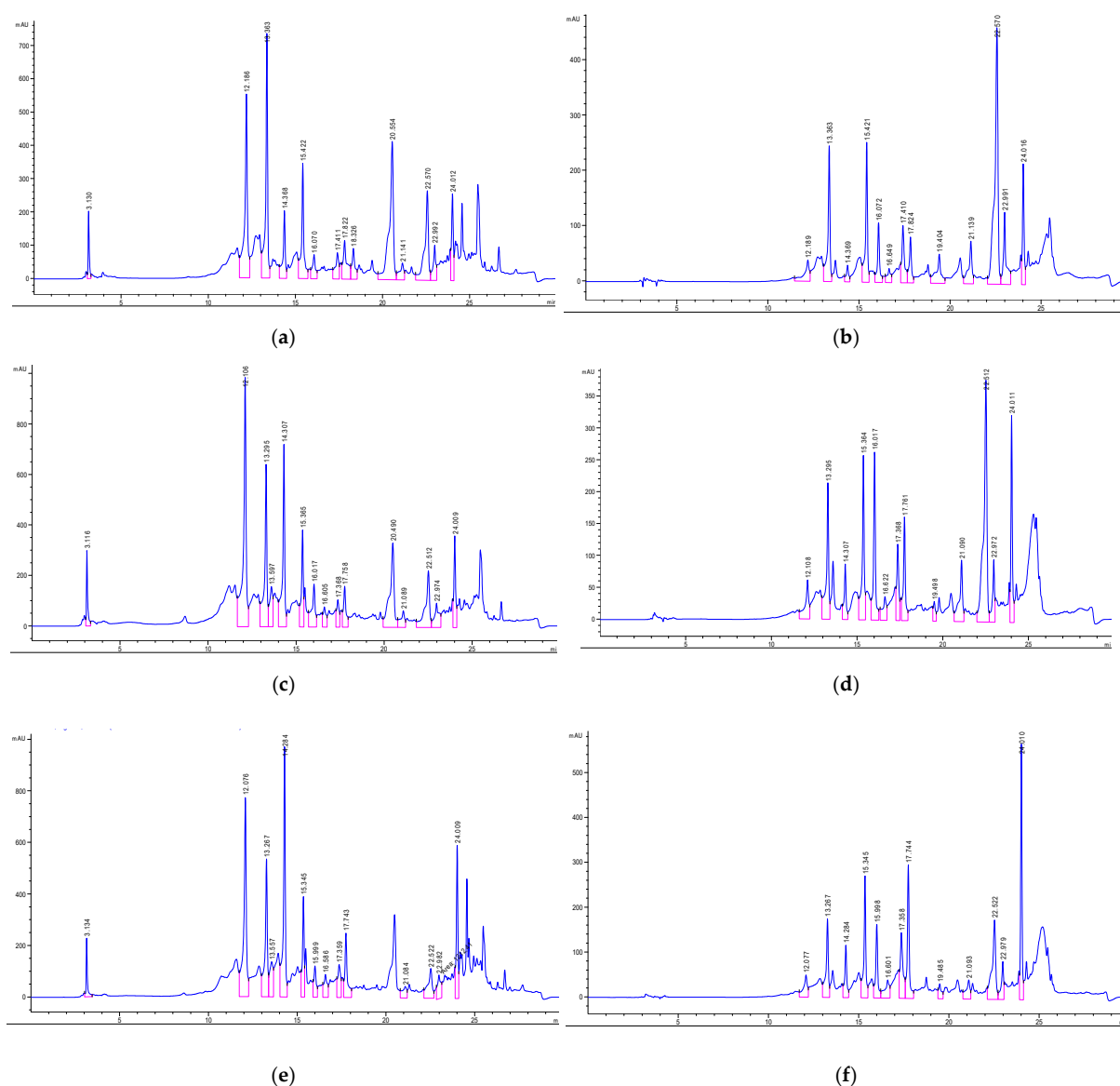


Figure 1. HPLC-DAD chromatograms of lavender extracts recorded at 280 nm and 340 nm. (a) ‘Moldoveanca 4’ at 280 nm; (b) ‘Moldoveanca 4’ at 340 nm; (c) ‘Sevtopolis’ at 280 nm; (d) ‘Sevtopolis’ at 340 nm; (e) ‘George 90’ at 280 nm; (f) ‘George 90’ at 340 nm. Retention times (Rt, min) correspond to the phenolic compounds tentatively identified by HPLC-DAD-ESI⁺ and listed in Table 1.

The phenolic profiles showed descriptive quantitative variation among the three investigated lavender extracts. In the ‘Moldoveanca 4’ extract, 4-methoxycinnamic acid showed the highest estimated class-equivalent concentration ($259.80 \pm 0.11 \mu\text{g/mL}$), followed by 2,4-dihydroxybenzoic acid-glucoside ($174.35 \pm 0.11 \mu\text{g/mL}$). In the ‘Sevtopolis’ extract, 2,4-dihydroxybenzoic acid-glucoside showed the highest estimated value ($312.40 \pm 0.10 \mu\text{g/mL}$), followed by 4-methoxycinnamic acid ($223.32 \pm 0.10 \mu\text{g/mL}$) and vanillic acid-glucuronide ($177.18 \pm 0.10 \mu\text{g/mL}$). In the ‘George 90’ extract, the highest estimated values were recorded for 2,4-dihydroxybenzoic acid-glucoside ($233.53 \pm 0.10 \mu\text{g/mL}$) and vanillic acid-glucuronide ($216.55 \pm 0.10 \mu\text{g/mL}$), describing a sample-specific phenolic profile under the analytical conditions employed. Rosmarinic acid was tentatively annotated in all three analyzed samples, with the highest estimated class-equivalent concentration in ‘Moldoveanca 4’ ($43.82 \pm 0.97 \mu\text{g/mL}$), followed by ‘George 90’ ($18.05 \pm 0.17 \mu\text{g/mL}$) and ‘Sevtopolis’ ($15.75 \pm 0.15 \mu\text{g/mL}$).

Table 2. Descriptive distribution of 14 tentatively annotated phenolic compounds in the lavender extracts ($\mu\text{g/mL}$ extract).

Compound		Subclass	‘Moldoveanca 4’	‘Sevtopolis’	‘George 90’
Luteolin-diglucoside	Lut-diglc	FLAV	12.66 ± 0.01	30.06 ± 0.04	19.08 ± 0.02
Luteolin-glucuronide	Lut-gur		4.50 ± 0.20	7.81 ± 0.10	10.41 ± 0.10
Apigenin-glucoside	Apig-glc		14.84 ± 0.45	14.09 ± 0.02	23.03 ± 0.03
Apigenin-glucuronide	Apig-gur		10.22 ± 0.20	1.60 ± 0.10	32.79 ± 0.15
Luteolin	Luteolin		13.84 ± 0.14	17.75 ± 0.10	8.94 ± 0.05
Apigenin	Apigenin		19.37 ± 0.11	11.50 ± 0.20	10.62 ± 0.06
5,6-Dihydroxy-7,8-dimethoxyflavone	5,6-diOH-7,8-diMeOF	HBA	19.14 ± 0.16	27.56 ± 0.06	43.79 ± 0.03
2-Hydroxybenzoic acid	2-OH-BA		26.03 ± 0.72	41.08 ± 0.01	31.77 ± 0.10
2,4-Dihydroxybenzoic acid-glucoside	2,4-diOH-BA-glc		174.35 ± 0.11	312.40 ± 0.10	233.53 ± 0.10
Vanillic acid-glucuronide	Vanillic-gur		52.41 ± 0.08	177.18 ± 0.10	216.55 ± 0.10
Ferulic acid-glucuronide	Ferulic-gur	HCA	90.27 ± 0.08	89.65 ± 0.15	71.50 ± 0.20
Ferulic acid-glucoside	Ferulic-glc		84.60 ± 0.14	94.70 ± 0.11	93.46 ± 0.09
4-Methoxycinnamic acid	4-MCA		259.80 ± 0.11	223.32 ± 0.10	110.50 ± 0.01
Rosmarinic acid	RA		43.82 ± 0.97	15.75 ± 0.15	18.05 ± 0.17

Values are expressed as mean $\pm$ SD of three technical replicate injections. HBA, hydroxybenzoic acid derivatives; HCA, hydroxycinnamic acid derivatives; FLAV, flavones.

The chromatographic sums and analytical repeatability data for the three extracts are presented in Table 3. The chromatographic sum, calculated from the class-equivalent concentrations of the fourteen tentatively annotated compounds, showed the highest value in the ‘Sevtopolis’ extract ($1064.44 \pm 1.034 \mu\text{g/mL}$), followed by ‘George 90’ ($924.03 \pm 1.132 \mu\text{g/mL}$) and ‘Moldoveanca 4’ ($825.87 \pm 2.300 \mu\text{g/mL}$). The mean coefficient of variation across all tentatively annotated compounds was 1.24% for ‘Moldoveanca 4’, 0.79% for ‘Sevtopolis’, and 0.32% for ‘George 90’, indicating good instrumental repeatability for all three extracts.

Table 3. Phenolic subclass distribution in the lavender extracts.

Parameter	Lavandula Genotypes		
	‘Moldoveanca 4’	‘Sevtopolis’	‘George 90’
Total, $\Sigma 14$ compounds ($\mu\text{g/mL}$)	825.87 ± 2.30	1064.44 ± 1.03	924.03 ± 1.13
Mean CV (%)	1.24	0.79	0.32
HBA total ($\mu\text{g/mL}$)	252.80 ± 0.74	530.66 ± 0.21	481.86 ± 0.30
HBA (% of total)	30.6	49.9	52.1
HCA total ($\mu\text{g/mL}$)	478.50 ± 0.99	423.42 ± 0.31	293.51 ± 0.41
HCA (% of total)	57.9	39.8	31.8
FLAV total ($\mu\text{g/mL}$)	94.58 ± 0.85	110.36 ± 0.53	148.66 ± 0.44
FLAV (% of total)	11.5	10.4	16.1
Dominant compound	4-Methoxycinnamic acid	2,4-Dihydroxybenzoic acid-glucoside	2,4-Dihydroxybenzoic acid-glucoside

Note: HBA, hydroxybenzoic acid derivatives; HCA, hydroxycinnamic acid derivatives; FLAV, chromatographic total of quantified flavone derivatives. Percentage values indicate the contribution of each phenolic subclass to the chromatographic sum calculated for each extract. Mean CV represents the average coefficient of variation calculated across the quantified compounds within each extract.

The relative distribution of phenolic subclasses also showed descriptive variation among the extracts. In ‘Moldoveanca 4’, hydroxycinnamic acid derivatives represented the largest proportion of the chromatographic sum (57.9%), whereas hydroxybenzoic acid derivatives represented the largest proportions in ‘Sevtopolis’ and ‘George 90’, accounting

for 49.9% and 52.1%, respectively. The flavone fraction represented 16.1% of the chromatographic sum in ‘George 90’, compared with 11.5% in ‘Moldoveanca 4’ and 10.4% in ‘Sevtopolis’.

To further illustrate the descriptive variation among the extracts, the class-equivalent concentrations of the tentatively annotated phenolic compounds are presented in Figure 2.

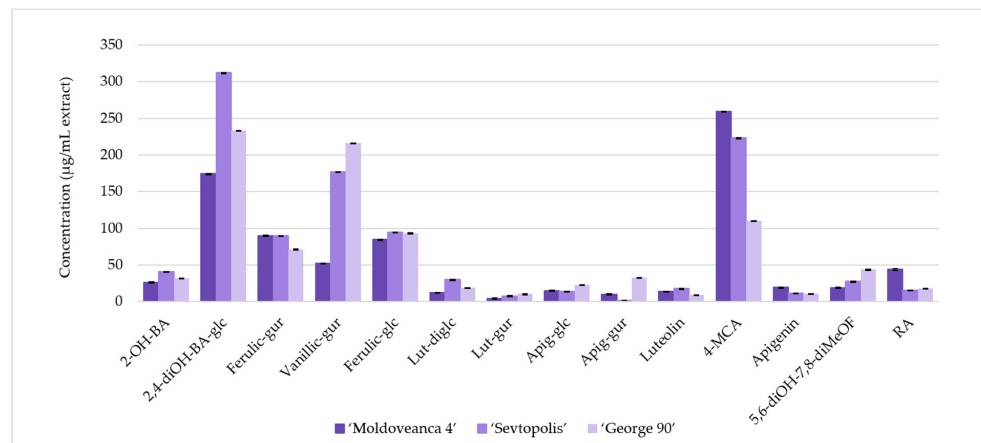


Figure 2. Descriptive distribution of the estimated class-equivalent concentrations of the 14 tentatively annotated phenolic compounds in the investigated lavender extracts. Bars represent mean $\pm$ SD. Values are expressed as concentration ($\mu\text{g/mL}$ extract).

2.2. Antioxidant Activity

The antioxidant activity of the lavender extracts, determined by the DPPH radical scavenging assay and expressed as Trolox equivalents, showed notable differences among the investigated extracts (Table 4). The highest antioxidant activity was recorded for ‘Sevtopolis’ ($6.92 \pm 0.76 \mu\text{mol TE/mL}$ extract), followed by ‘George 90’ ($4.80 \pm 0.44 \mu\text{mol TE/mL}$), whereas ‘Moldoveanca 4’ exhibited the lowest value ($1.50 \pm 0.14 \mu\text{mol TE/mL}$). The observed trend (‘Sevtopolis’ > ‘George 90’ > ‘Moldoveanca 4’) was consistent with the variation in phenolic compounds tentatively identified and quantified by HPLC-DAD-ESI⁺ analysis, suggesting a possible association between phenolic composition and DPPH radical scavenging activity in the analyzed extracts.

Table 4. DPPH antioxidant activity of the investigated lavender extracts ($\mu\text{mol TE/mL}$ extract).

Genotypes	Antioxidant Activity ($\mu\text{mol TE/mL}$ Extract)
‘Moldoveanca 4’	1.50 ± 0.14
‘George 90’	4.80 ± 0.44
‘Sevtopolis’	6.92 ± 0.76

Values are expressed as mean $\pm$ SD and reported as μmol Trolox equivalents per mL of extract ($\mu\text{mol TE/mL}$ extract).

3. Discussion

The present study provides a comparative characterization of the phenolic composition and antioxidant activity of three cultivated Eastern European *Lavandula* genotypes, namely the *L. angustifolia* cultivars ‘Moldoveanca 4’ and ‘Sevtopolis’ and the *L. $\times$ intermedia* genotype ‘George 90’. Although all three genotypes shared a similar qualitative profile, consisting of fourteen tentatively annotated phenolic compounds, quantitative differences were observed among the analyzed extracts for all compounds.

The observed variability is consistent with previous studies showing that the phenolic composition of lavender is influenced by multiple factors, including genotype, geographical

origin, environmental conditions, plant developmental stage, cultivation practices, and extraction methodology. Adaszyńska-Skwirzyńska and Dziecioł [5] reported considerable differences in phenolic acids and flavonoids among *L. angustifolia* cultivars cultivated in Poland, highlighting the importance of genetic factors in determining the final phytochemical profile. Similarly, Giosanu et al. [8] emphasized that lavender flowers contain complex mixtures of hydroxybenzoic acids, hydroxycinnamic acids, and flavonoids, whose relative abundance varies substantially among cultivars and growing conditions. These observations are consistent with the quantitative differences observed among the ‘Moldoveanca 4’, ‘Sevtopolis’, and ‘George 90’ extracts, illustrating the descriptive variability among the specific lavender extracts analyzed [4,5,8].

Interestingly, the predominant phenolic compounds tentatively annotated in the present study differed from those most frequently reported for lavender, where rosmarinic acid, caffeic acid derivatives, and luteolin glycosides are often described as major constituents. In the analyzed samples, the highest estimated class-equivalent concentrations were recorded for 2,4-dihydroxybenzoic acid-glucoside, vanillic acid-glucuronide, and 4-methoxycinnamic acid. Rosmarinic acid was also tentatively annotated in all three analyzed samples, although its estimated levels were lower than those of the predominant phenolic compounds. In comparison, Dobros et al. reported rosmarinic acid concentrations ranging from 2.52 to 10.82 mg/g of freeze-dried extract in flower preparations obtained from *L. angustifolia* and *L. × intermedia* cultivars. The reported concentrations varied according to the extraction procedure, ranging from 2.52 to 7.18 mg/g in decoctions, 3.31–10.82 mg/g in ultrasound-assisted extracts, and 3.91–9.17 mg/g in ethanolic macerates [3]. Similarly, Betlej et al. identified rosmarinic acid as one of the predominant compounds in ethanolic flower extracts from two *L. angustifolia* ecotypes, with concentrations ranging from 829.68 to 1229.33 µg/g [13]. These findings indicate that the reported levels of rosmarinic acid may vary considerably depending on the plant material, extraction procedure, and analytical methodology. Nevertheless, a direct numerical comparison with the present results is limited because our concentrations were expressed in µg/mL extract as class-equivalent estimates, whereas the cited studies reported values relative to the mass of the dried or freeze-dried extract. Moreover, because the three lavender materials investigated in the present study were cultivated at the same location under comparable conditions, the differences observed among them are interpreted as sample-specific analytical patterns. Further studies using independent biological replicates are required to determine whether these differences are associated with genotype.

Among the analyzed extracts, the ‘Sevtopolis’ exhibited the highest cumulative concentration of quantified phenolic compounds (1064.44 ± 1.03 µg/mL extract), followed by ‘George 90’ (924.03 ± 1.13 µg/mL extract) and ‘Moldoveanca 4’ (825.87 ± 2.30 µg/mL extract). This finding illustrates the considerable phytochemical variability that may occur even among closely related lavender materials. Previous investigations on Romanian lavender germplasm similarly reported significant differences in the abundance of phenolic compounds among *L. angustifolia*, *L. latifolia*, and *L. × intermedia* genotypes, indicating that phenolic profiles may vary among different *Lavandula* species and cultivated materials [3,4].

The distribution of phenolic subclasses further showed descriptive differences among the investigated extracts. ‘Moldoveanca 4’ was characterized by the predominance of hydroxycinnamic acid derivatives, accounting for 57.9% of the chromatographic sum, whereas hydroxybenzoic acid derivatives represented the dominant subclass in both ‘Sevtopolis’ and ‘George 90’, accounting for 49.9% and 52.1%, respectively. These descriptive differences indicate distinct phenolic profiles among the specific extracts analyzed. Similar variations in the relative abundance of hydroxybenzoic and hydroxycinnamic acid derivatives have been reported previously among *Lavandula* species and cultivars [4,5,8].

Particularly noteworthy was the distribution of the characteristic phenolic compounds associated with each extract. The ‘Moldoveanca 4’ extract showed the highest estimated class-equivalent concentration of 4-methoxycinnamic acid, whereas the ‘Sevtopolis’ extract showed the highest estimated concentration of 2,4-dihydroxybenzoic acid-glucoside. In contrast, ‘George 90’ was characterized by markedly increased concentrations of vanillic acid-glucuronide together with the highest proportion of flavones among the investigated extracts. Within this limited dataset, these compounds contributed to the descriptive differentiation of the analyzed extracts; their potential relevance as phytochemical markers requires confirmation using independent biological replicates and a larger panel of lavender materials. The profile observed for the ‘George 90’ extract represents a sample-specific analytical pattern that requires confirmation using independent biological replicates and a broader comparative dataset [4].

The flavone derivatives were particularly abundant in the ‘George 90’ extract, accounting for 16.1% of its chromatographic sum. Elevated concentrations of apigenin-glucuronide and 5,6-dihydroxy-7,8-dimethoxyflavone contributed substantially to this profile. Flavones are recognized as important bioactive constituents due to their antioxidant, anti-inflammatory, antimicrobial, and neuroprotective properties, and their accumulation may enhance the functional value of lavender extracts [4].

Among the analyzed extracts, ‘Sevtopolis’ showed both the highest chromatographic sum of estimated class-equivalent phenolic concentrations and the strongest DPPH radical-scavenging activity. The other two extracts followed the same descending order for these parameters, with ‘George 90’ showing intermediate values and ‘Moldoveanca 4’ the lowest values. This parallel ranking suggests a possible correspondence between the estimated phenolic composition and DPPH activity within the present dataset. However, because only three extracts were analyzed and independent biological replicates were not available, this observation should not be interpreted as evidence of a statistical association or causal relationship. Similar relationships between phenolic abundance and antioxidant activity have been reported for lavender cultivars in previous studies, although the compounds contributing to antioxidant activity may differ among plant materials and extracts [3,4].

The cultivar ‘Moldoveanca 4’ displayed the lowest chromatographic sum of the estimated class-equivalent concentrations but the highest proportion of hydroxycinnamic acid derivatives, mainly represented by 4-methoxycinnamic acid. Previous investigations on this cultivar have focused predominantly on essential oil composition, antioxidant capacity, and antimicrobial activity, demonstrating that ‘Moldoveanca 4’ possesses a valuable phytochemical profile despite substantial compositional differences among extraction products. The predominance of hydroxycinnamic acid derivatives observed in the present study suggests that the biological potential of this cultivar may be associated not only with volatile constituents but also with non-volatile phenolic metabolites [9].

The antioxidant activity determined by the DPPH assay followed the same ranking as the cumulative estimated class-equivalent concentrations of the tentatively annotated phenolic compounds, with ‘Sevtopolis’ exhibiting the highest radical-scavenging activity, followed by ‘George 90’ and ‘Moldoveanca 4’. This agreement suggests that phenolic compounds may contribute to the antioxidant potential of the investigated extracts. The tentatively annotated flavone derivatives, including luteolin- and apigenin-based compounds, may contribute to radical scavenging through hydrogen- or electron-donating mechanisms and stabilization of the resulting radicals. Their antioxidant contribution may vary according to their concentration, hydroxylation and glycosylation patterns, and interactions with other phenolic constituents. Notably, ‘George 90’ contained the highest concentration and proportion of chromatographically quantified flavone derivatives, whereas ‘Sevtopolis’ showed the strongest DPPH activity. This non-parallel pattern sug-

gests that flavone derivatives were not the sole determinants of the observed antioxidant activity, which may instead reflect the combined contribution of several phenolic classes. Numerous studies on *Lavandula* species have similarly reported positive relationships between phenolic concentration and antioxidant activity measured using DPPH, ABTS, and FRAP assays, which is broadly consistent with the potential contribution of phenolic metabolites observed here.

The main strength of this research lies in providing an integrated preliminary analytical characterization of the phenolic profiles and DPPH radical-scavenging activity of three commercially cultivated Eastern European lavender materials. HPLC-DAD-ESI⁺ profiling enabled the tentative annotation of fourteen phenolic compounds and the estimation of their class-equivalent concentrations, thereby expanding the limited phytochemical information available for ‘Moldoveanca 4’, ‘Sevtopolis’, and ‘George 90’. The observed differences are interpreted as sample-specific analytical patterns and provide baseline data for future studies incorporating independent biological replicates to investigate potential genotype-related variation. Such studies may further support the evaluation and potential valorization of these lavender materials for food, cosmetic, nutraceutical, and pharmaceutical applications.

Study Limitations

A key limitation of this study is that only one extract was prepared from each lavender material. The three replicate HPLC injections were used exclusively to assess analytical repeatability and do not represent independent biological replicates. Consequently, the observed differences should be regarded as descriptive and specific to the analyzed samples rather than representative of population-level or genotype-dependent variability. In addition, the compound assignments remain tentative because authentic reference standards were not available for all analytes and confirmatory MS/MS data were not obtained. Antioxidant activity was assessed using only one in vitro method, namely the DPPH assay. Future studies should include independent plant samples, separately prepared extraction replicates, confirmatory analytical methods, and complementary antioxidant assays to validate the observed patterns and investigate potential genotype-related differences. In addition, total phenolic content and total flavonoid content were not evaluated using complementary spectrophotometric assays.

4. Materials and Methods

4.1. Plant Material and Extraction

Dried inflorescences from the three *Lavandula* genotypes were the plant material used for extraction and analysis in this study. Details regarding the origin, collection, and authentication of the plant material are provided in Table 5.

Table 5. Botanical identity and origin of the investigated lavender genotypes.

Characteristic	‘Moldoveanca 4’	‘Sevtopolis’	‘George 90’
Genus	<i>Lavandula</i>	<i>Lavandula</i>	<i>Lavandula</i>
Taxonomic affiliation	<i>Lavandula angustifolia</i> Mill.	<i>Lavandula angustifolia</i> Mill.	<i>Lavandula</i> × <i>intermedia</i> Emeric ex Loisel.
Taxonomic group	True Lavender	True Lavender	Lavandin
Genetic origin	Species genotype	Species genotype	Natural hybrid genotype, (<i>Lavandula angustifolia</i> × <i>Lavandula latifolia</i>)
Geographical origin	Republic of Moldova	Bulgaria	Romania
Material type	cultivar	cultivar	hybrid genotype

To clarify the botanical classification of the investigated plant material, the taxonomic relationships among the lavender genotypes included in the study are illustrated in Figure 3.

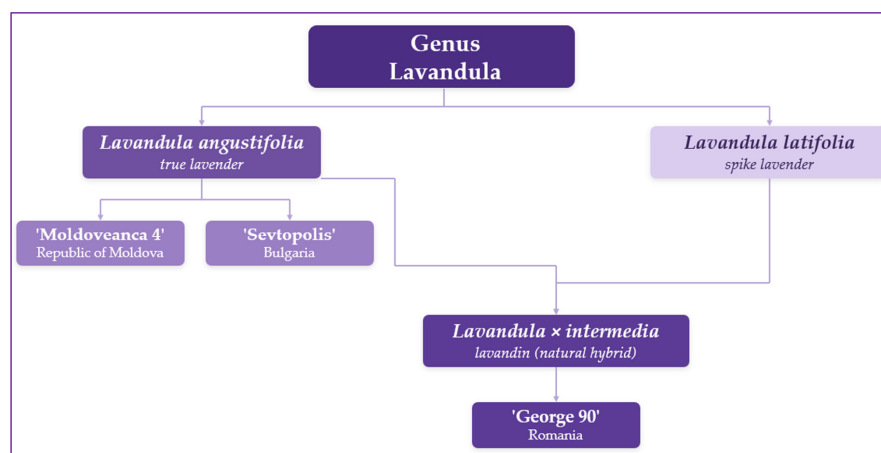


Figure 3. Taxonomic relationships among the lavender genotypes investigated in the present study.

All three lavender genotypes were cultivated under the same environmental and agronomic conditions in an organically managed perennial crop located on a farm in Botoșani County, Romania (47°41'51" N, 26°38'53" E). The plantation was established in 2016, and no fertilizers were applied during the 2025 growing season. The inflorescences were harvested manually in the second half of June 2025, when approximately 50% of the flowers were open. Harvesting was performed on sunny days between 10:00 and 11:30 a.m. After harvesting, the inflorescences were dried at 20 °C. The dried plant material was stored in paper bags under ambient laboratory conditions until extraction.

For the preparation of the extracts, 15 g of dried and powdered inflorescences from each lavender genotype were mixed with 200 mL of 80% ethanol. The samples were soaked for 90 min prior to extraction, according to the procedure recommended by Pan et al. (2003) [14].

Microwave-assisted extraction was then performed using a domestic microwave oven (CE3260F/CE3260FS), under conditions adapted from Levaya et al. (2022), with a nominal output power of 1100 W [15]. The suspensions were placed in open glass vessels with a nominal capacity of 300 mL. The microwave oven was operated at power level 1 (10% of total power), corresponding to approximately 110 W. Each irradiation cycle consisted of 10 s of microwave exposure followed by a 50 s pause. A total of 6 cycles was required to reach 55 °C. During each pause, the suspension temperature was measured using a digital thermometer (Testo 108-2, Testo SE & Co. KGaA, Titisee-Neustadt, Germany). After reaching 55 °C, the samples were maintained at this temperature for 3 min using 3 additional intermittent cycles under the same irradiation and pause conditions. The samples were then cooled to room temperature and filtered through Whatman No. 1 filter paper. The final extract volume was measured and adjusted to 200 mL with 80% ethanol to compensate for evaporation. The liquid extracts were stored at approximately 4 °C in amber glass vials and analyzed by HPLC, without prior evaporation or drying.

4.2. HPLC-DAD-ESI⁺ Conditions

Prior to chromatographic analysis, the lavender extracts were filtered through a Chromafil Xtra nylon 0.45 µm filter (MACHEREY-NAGEL GmbH & Co. KG, Düren, Germany), and 20 µL of each filtered sample was injected into the HPLC system. Analyses were performed using an Agilent 1200 HPLC system (Agilent Technologies, Waldbronn, Germany) coupled to an Agilent 6110 single-quadrupole mass spectrometer (Agilent Technologies, Santa Clara, CA, USA). The system was equipped with a quaternary pump, solvent degasser, autosampler, diode-array detector (DAD), and electrospray ionization source. Chromatographic separation was carried out on a Kinetex XB-C18 column (4.6 × 150 mm,

5 μm ; Phenomenex, Torrance, CA, USA). The mobile phase consisted of water containing 0.1% acetic acid as solvent A and acetonitrile containing 0.1% acetic acid as solvent B. Elution was performed using the following gradient program, expressed as solvent B: 0–2 min, 5% B; 2–18 min, 5–40% B; 18–20 min, 40–90% B; 20–24 min, 90% B; 24–25 min, 90–5% B; and 25–30 min, 5% B. The flow rate was 0.5 mL/min, and the column temperature was maintained at 25 °C [16,17]. DAD spectral data were recorded in the 200–600 nm range for all detected peaks, and chromatograms were monitored at 280 and 340 nm. Mass spectrometric detection was performed in positive electrospray ionization mode (ESI⁺), using full-scan acquisition under the following operating conditions: capillary voltage, 3000 V; source temperature, 350 °C; nitrogen gas flow, 7 L/min; and mass range, m/z 120–1200. Data acquisition and interpretation were performed using Agilent ChemStation software, version Rev B.02.01-SR2.

For each genotype, three technical replicate injections (R1–R3) were performed from a single extract, allowing the assessment of analytical repeatability and relative quantitative differences among the analyzed genotype-derived extracts.

4.3. Calibration and Quantification

Five-point external calibration curves were constructed using methanolic solutions of gallic acid, chlorogenic acid, and luteolin (Sigma-Aldrich, St. Louis, MO, USA) as reference standards. The calibration concentrations were 5, 10, 25, 50, and 100 $\mu\text{g/mL}$ for gallic acid; 10, 25, 30, 40, and 50 $\mu\text{g/mL}$ for chlorogenic acid; and 1, 10, 25, 50, and 100 $\mu\text{g/mL}$ for luteolin. The calibration equations were $y = 33.624x + 30.680$ for gallic acid ($R^2 = 0.9978$), $y = 22.585x - 36.728$ for chlorogenic acid ($R^2 = 0.9937$), and $y = 68.857x + 25.113$ for luteolin ($R^2 = 0.9972$), where x represents the standard concentration ($\mu\text{g/mL}$) and y represents the chromatographic peak area (mAU). The LOD and LOQ values were 0.23 and 0.89 $\mu\text{g/mL}$ for gallic acid, 0.41 and 1.64 $\mu\text{g/mL}$ for chlorogenic acid, and 0.38 and 1.46 $\mu\text{g/mL}$ for luteolin, respectively. Where necessary, the extracts were appropriately diluted to ensure that all chromatographic responses fell within the corresponding calibration ranges. Hydroxybenzoic acid derivatives were quantified as gallic acid equivalents, hydroxycinnamic acid derivatives as chlorogenic acid equivalents, and flavone derivatives as luteolin equivalents. Therefore, the reported values represent class-equivalent concentrations and should not be interpreted as absolute concentrations determined using an authentic standard for each individual compound. The fourteen phenolic compounds were tentatively annotated based on retention behavior, UV–Vis spectral characteristics, protonated molecular ions $[M+H]^+$, and comparison with data reported in the literature and the Phenol-Explorer database [18]. As authentic standards were not available for all compounds, the assignments were considered tentative and require further confirmation [19].

For each extract, the chromatographic sum of phenolic compounds was calculated by adding the class-equivalent concentrations of all fourteen tentatively annotated compounds. The chromatographic sum of flavone derivatives was calculated from the seven flavones quantified as luteolin equivalents: luteolin-diglucoside, luteolin-glucuronide, apigenin-glucoside, apigenin-glucuronide, luteolin, apigenin, and 5,6-dihydroxy-7,8-dimethoxyflavone.

4.4. Determination of Antioxidant Activity by DPPH Assay

The antioxidant activity of lavender extracts was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH 80 μM) radical scavenging method, following a widely adopted protocol [20], previously used in combination with HPLC-based phenolic screening for the evaluation of medicinal plant extracts [21,22].

Briefly, 100 µL of each extract was mixed with 3.9 mL of freshly prepared DPPH methanolic solution. The reaction mixtures were incubated in the dark at room temperature for 30 min, after which the absorbance was measured at 517 nm using a UV-Vis spectrophotometer (PG Instruments Ltd., Leicestershire, UK). A DPPH solution without extract was used as the control.

The radical scavenging activity was calculated according to the following equation:

$$\text{DPPH inhibition (\%)} = \frac{A_{\text{control}} - A_{\text{sample}}}{A_{\text{control}}} \times 100$$

where A_{control} is the absorbance of the DPPH solution and A_{sample} is the absorbance of the reaction mixture containing the extract.

Trolox was used as the reference antioxidant and a calibration curve was prepared using standard Trolox solutions. The results were expressed as Trolox equivalents (TE) and calculated from the calibration equation:

$$y = 65.705x + 1.8803$$

where y represents the percentage of DPPH inhibition and x the Trolox concentration (mM). All measurements were performed in triplicate, and the results were expressed as mean $\pm$ SD. Antioxidant activity was reported as µmol Trolox equivalents per mL of extract (µmol TE/mL extract).

4.5. Data Presentation and Descriptive Analysis

All results are presented as mean $\pm$ standard deviation (SD) of three technical measurements, consisting of replicate injections for HPLC analysis and replicate determinations for the DPPH assay. HPLC results are reported as class-equivalent concentrations (µg/mL extract). The coefficient of variation was calculated as $\text{CV (\%)} = \text{SD}/\text{mean} \times 100$. Mean CV values reported for each extract represent the arithmetic mean of the compound-specific CVs across the 14 tentatively annotated compounds. Descriptive calculations and graphical representations were generated using Microsoft Excel.

5. Conclusions

This exploratory study provided a preliminary HPLC-DAD-ESI⁺ characterization of the phenolic composition and DPPH radical-scavenging activity of three lavender materials: the *L. angustifolia* cultivars ‘Moldoveanca 4’ and ‘Sevtopolis’ and the *L. × intermedia* genotype ‘George 90’. Fourteen phenolic compounds belonging to the hydroxybenzoic acid, hydroxycinnamic acid, and flavone classes were tentatively annotated, and their levels were estimated as class-equivalent concentrations. Among the analyzed samples, ‘Sevtopolis’ showed the highest chromatographic sum of phenolic compounds and the strongest DPPH radical-scavenging activity, ‘George 90’ had the highest relative contribution of flavones, and ‘Moldoveanca 4’ was characterized by a predominance of hydroxycinnamic acid derivatives, particularly 4-methoxycinnamic acid. These findings represent sample-specific analytical patterns under the investigated conditions and should not be interpreted as evidence of genotype-dependent variation. The results expand the available phytochemical information on these Eastern European lavender materials and provide baseline data for future studies using independent biological replicates, controlled cultivation conditions, and complementary analytical and antioxidant methods.

Author Contributions: Conceptualization, M.D.T., M.B.P., G.S.B. and D.G.; methodology, A.L.P., T.S.N., M.B., M.D.T., M.B.P. and D.G.; software, T.S.N. and M.O.B.; validation, M.D.T., M.B.P., M.O.B., M.A.G. and D.G.; formal analysis, M.B., M.B.P., G.S.B. and D.G.; investigation, M.B., M.O.B., M.B.P.,

M.D.T., A.L.P., T.S.N., M.A.G., G.S.B. and D.G.; resources, M.A.G. and D.G.; data curation, M.B., T.S.N., M.B.P. and M.O.B.; writing—original draft preparation, M.B. and M.B.P.; writing—review and editing, M.B., M.O.B., M.B.P., M.D.T., A.L.P., T.S.N., M.A.G., G.S.B. and D.G.; visualization, M.B., M.O.B., M.B.P., M.D.T., A.L.P., T.S.N., M.A.G., G.S.B. and D.G.; supervision, M.D.T., M.B.P. and D.G.; project administration, M.B.P. and D.G. All authors have read and agreed to the published version of the manuscript.

Funding: The APC was funded by the University of Oradea, Oradea, Romania.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are available upon request from the first or the last author.

Acknowledgments: The authors acknowledge the support of the Center for Research in Medical, Pharmaceutical, and Dental Sciences (Faculty of Medicine and Pharmacy, University of Oradea, Romania). The authors express their gratitude to the University of Oradea, Oradea, Romania, for supporting the APC.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

2,4-diOH-BA-glc	2,4-Dihydroxybenzoic acid-glucoside
2-OH-BA	2-Hydroxybenzoic acid
4-MCA	4-Methoxycinnamic acid
5,6-diOH-7,8-diMeOF	5,6-Dihydroxy-7,8-dimethoxyflavone
Apig-glc	Apigenin-glucoside
Apig-gur	Apigenin-glucuronide
CV	Coefficient of Variation
DPPH	2,2-Diphenyl-1-picrylhydrazyl
ESI ⁺	Positive Electrospray Ionization
Ferulic-glc	Ferulic acid-glucoside
Ferulic-gur	Ferulic acid-glucuronide
FLAV	Flavones (total flavone derivatives)
HBA	Hydroxybenzoic acid (derivatives)
HCA	Hydroxycinnamic acid (derivatives)
HPLC-DAD	High-Performance Liquid Chromatography with Diode-Array Detection
Lut-diglc	Luteolin-diglucoside
Lut-gur	Luteolin-glucuronide
[M+H] ⁺	Protonated molecular ion
Rt	Retention time
RA	Rosmarinic acid
SD	Standard Deviation
TE	Trolox Equivalents
UV-Vis	Ultraviolet-Visible (spectroscopy)
Vanillic-gur	Vanillic acid-glucuronide
λ _{max}	Wavelength of maximum absorbance

References

1. Bungau, S.G.; Popa, V.C. Between Religion and Science Some Aspects Concerning Illness and Healing in Antiquity. *Transylv. Rev.* **2015**, *24*, 3–18.
2. Zhelyazkova, M.; Badzhelova, V.; Stanev, S. Assessment of Genetic Diversity Among Bulgarian Lavender Varieties Using Scot Markers. *Agronomy* **2025**, *15*, 2889. [[CrossRef](#)]

3. Dobros, N.; Zawada, K.; Paradowska, K. Phytochemical Profile and Antioxidant Activity of *Lavandula angustifolia* and *Lavandula × intermedia* Cultivars Extracted with Different Methods. *Antioxidants* **2022**, *11*, 711. [[CrossRef](#)] [[PubMed](#)]
4. Marchidan, I.G.; Ortan, A.; Marcu Spinu, S.; Avramescu, S.M.; Avram, I.; Fierascu, R.C.; Babeanu, N. Chemical Composition and Biological Properties of New Romanian *Lavandula* Species. *Antioxidants* **2023**, *12*, 2127. [[CrossRef](#)] [[PubMed](#)]
5. Adaszyńska-Skwirzyńska, M.; Dziecioł, M. Comparison of phenolic acids and flavonoids contents in various cultivars and parts of common lavender (*Lavandula angustifolia*) derived from Poland. *Nat. Prod. Res.* **2017**, *31*, 2575–2580. [[CrossRef](#)] [[PubMed](#)]
6. Dobros, N.; Zawada, K.D.; Paradowska, K. Phytochemical Profiling, Antioxidant and Anti-Inflammatory Activity of Plants Belonging to the *Lavandula* Genus. *Molecules* **2023**, *28*, 256. [[CrossRef](#)] [[PubMed](#)]
7. Torras-Claveria, L.; Jauregui, O.; Bastida, J.; Codina, C.; Viladomat, F. Antioxidant activity and phenolic composition of Lavandin (*Lavandula × intermedia* Emeric ex Loiseleur) waste. *J. Agric. Food Chem.* **2007**, *55*, 8436–8443. [[CrossRef](#)] [[PubMed](#)]
8. Giosanu, D.; Vijan, L.; Topala, C.; Oprea, M. Investigations on the bioactive compounds and ornamental properties of some lavender cultivars. *Horticulture* **2024**, *68*, 673–680.
9. Bogdan, M.A.; Bungau, S.; Tit, D.M.; Zaha, D.C.; Nechifor, A.C.; Behl, T.; Chambre, D.; Lupitu, A.I.; Copolovici, L.; Copolovici, D.M. Chemical Profile, Antioxidant Capacity, and Antimicrobial Activity of Essential Oils Extracted from Three Different Varieties (Moldoveanca 4, Vis Magic 10, and Alba 7) of *Lavandula angustifolia*. *Molecules* **2021**, *26*, 4381. [[CrossRef](#)] [[PubMed](#)]
10. Bogdan, M.; Bungau, S.; Tit, D.M.; Copolovici, L.; Behl, T.; Otrisal, P.; Aleya, L.; Cioca, G.; Berescu, D.; Uivarosan, D.; et al. Variations in the Chemical Composition of the Essential Oil of *Lavandula angustifolia* Mill., Moldoveanca 4 Romanian Variety. *Rev. Chim.* **2020**, *71*, 307–331. [[CrossRef](#)]
11. Crișan, I.; Ona, A.; Vârban, D.; Muntean, L.; Vârban, R.; Stoie, A.; Mihăiescu, T.; Morea, A. Current Trends for Lavender (*Lavandula angustifolia* Mill.) Crops and Products with Emphasis on Essential Oil Quality. *Plants* **2023**, *12*, 357. [[CrossRef](#)] [[PubMed](#)]
12. Bogdan, M.; Endres, L.; Pasca, B.; Tit, D.M.; Uivarosan, D.; Copolovici, D.M.; Aleya, L.; Bungau, S. Study on the Stability and Compatibility of the Cosmetic Products with *Lavandula angustifolia* Oil Kept in PPH Polypropylene Homopolymer Plastic Containers. *Mater. Plast.* **2019**, *56*, 133–137. [[CrossRef](#)]
13. Betlej, I.; Andres, B.; Cebulak, T.; Kapusta, I.; Balawejder, M.; Żurek, N.; Jaworski, S.; Lange, A.; Kutwin, M.; Pisulewska, E.; et al. Phytochemical Composition and Antimicrobial Properties of New *Lavandula angustifolia* Ecotypes. *Molecules* **2024**, *29*, 1740. [[CrossRef](#)] [[PubMed](#)]
14. Pan, X.; Niu, G.; Liu, H. Microwave-assisted extraction of tea polyphenols and tea caffeine from green tea leaves. *Chem. Eng. Process. Process Intensif.* **2003**, *42*, 129–133. [[CrossRef](#)]
15. Levaya, Y.K.; Erkenuly, Z.M.; Abdulkhakimovna, A.G.; Saule, B.A. Evaluation of Antibacterial Activity of *Salvia stepposa* Extracts Isolated using Microwave Extraction, Growing Wild in Kazakhstan. *Trends Sci.* **2022**, *19*, 3217. [[CrossRef](#)]
16. Tocai, A.-C.; Ranga, F.; Teodorescu, A.G.; Pallag, A.; Vlad, A.M.; Bandici, L.; Vicas, S.I. Evaluation of Polyphenolic Composition and Antimicrobial Properties of *Sanguisorba officinalis* L. and *Sanguisorba minor* Scop. *Plants* **2022**, *11*, 3561. [[CrossRef](#)] [[PubMed](#)]
17. Gitea, D.; Gitea, M.A.; Radu, A.-F.; Pasca, M.B.; Bungau, S.G.; Tit, D.M. Antioxidant Capacity and Phenolic Profile of Defatted Seed Powder Derived from Organically Grown Vine Crops. *Bull. University Agric. Sci. Vet. Med. Cluj-Napoca Food Sci. Technol.* **2024**, *81*, 51–63. [[CrossRef](#)] [[PubMed](#)]
18. Neveu, V.; Pérez-Jiménez, J.; Vos, F.; Crespy, V.; du Chaffaut, L.; Mennen, L.; Knox, C.; Eisner, R.; Cruz, J.; Wishart, D.; et al. Phenol-Explorer: An online comprehensive database on polyphenol contents in foods. *Database* **2010**, *2010*, bap024. [[CrossRef](#)] [[PubMed](#)]
19. Sumner, L.W.; Amberg, A.; Barrett, D.; Beale, M.H.; Beger, R.; Daykin, C.A.; Fan, T.W.-M.; Fiehn, O.; Goodacre, R.; Griffin, J.L.; et al. Proposed minimum reporting standards for chemical analysis Chemical Analysis Working Group (CAWG) Metabolomics Standards Initiative (MSI). *Metabolomics* **2007**, *3*, 211–221. [[CrossRef](#)] [[PubMed](#)]
20. Brand-Williams, W.; Cuvelier, M.E.; Berset, C. Use of a free radical method to evaluate antioxidant activity. *LWT-Food Sci. Technol.* **1995**, *28*, 25–30. [[CrossRef](#)]
21. Gitea, D.; Vicas, S.; Gitea, M.A.; Nemeth, S.; Tit, D.M.; Pasca, B.; Purza, L.; Iovan, C. HPLC Screening of Bioactives Compounds and Antioxidant Capacity of Different Hypericum Species. *Rev. Chim.* **2018**, *69*, 305–309. [[CrossRef](#)]
22. Pasca, M.B.; Costa, A.-D.; Gitea, D.; Moisa, C.; Jurca, T.; Burlou-Nagy, C.; Olah, N.K.; Pallag, A.; Gitea, M.A. Comprehensive Pharmacobotanical and Phytochemical Profiling of *Glechoma hederacea* L. from Bihor County, North-West Romania. *Life* **2025**, *15*, 1466. [[CrossRef](#)] [[PubMed](#)]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.