# BIOLOGICAL SCIENCES

## ANTIOXIDANT ACTIVITY OF *HYSSOPUS OFFICINALIS* AND *DRACOCEPHALUM MOLDAVICA* VARIETIES UNDER INTRODUCTION AND CULTIVATION CONDITIONS IN ARMENIA

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**Abstract**

The antioxidant activity of methanolic extracts from introduced varieties of *Hyssopus officinalis* and *Dracocephalum moldavica was* evaluated under introduction and cultivation conditions in Armenia. Aerial parts of three varieties from each species were collected during flowering and extracted with 70% methanol. Antioxidant potential was assessed using the DPPH radical-scavenging assay at concentrations of 50, 100, and 200 μg/mL Results showed concentration-dependent activity across all samples, with variety Gorynych (*D. moldavica*) exhibiting the highest inhibition (85.3% at 200 μg/mL), followed by Accord (*H. officinalis*, 78.5%). Significant differences ($p < 0.05$) were observed among varieties within each species, reflecting the influence of genetic variation. The antioxidant activity positively correlated with previously reported total phenolic, flavonoid, and phenolic acid contents in these varieties. These findings highlight the potential of selected hyssop and Moldavian dragonhead varieties for use in functional food development and support their value as multifunctional crops under Armenian agroecological conditions.

**Keywords:** hyssop, Moldavian dragonhead, DPPH assay, functional food.

**Introduction.** The role of multifunctional plants in sustainable agriculture is increasingly recognized, as these species offer a wide range of benefits beyond their primary use as food. They provide essential nutrients, possess medicinal properties, and contribute to ecosystem services such as pollination and soil health (Parada and Salas, 2024). Crop diversification through the cultivation of multifunctional plants is a key approach for enhancing agrobiodiversity, strengthening resilience in agricultural systems, and creating income-generating opportunities for smallholder farmers (Gawdiya et al., 2025).

*Hyssopus officinalis* L. (hyssop) and *Dracocephalum moldavica* L. (Moldavian dragonhead) are two aromatic and medicinal plants known for their therapeutic potential, including antimicrobial and anti-inflammatory effects. Hyssop is traditionally used in herbal medicine for its essential oil content and pharmacological activity (Atazhanova et al.), while Moldavian dragonhead is valued for its pleasant aroma and reported health-promoting properties (Kozłowicz et al.). Although numerous studies worldwide have investigated the antioxidant activity of these species, the varieties introduced into Armenia have not been previously studied in this context. This research represents the first attempt to assess the antioxidant activity of introduced varieties of hyssop and Moldavian dragonhead cultivated under the valley conditions of Armenia.

These species naturally occur in the wild flora of Armenia (Flora of Armenia, 1987), which suggests that the introduced varieties are likely to adapt well to local environmental conditions. Given the absence of targeted breeding programs for these crops in the country, the introduction and evaluation of new varieties not only fills a research and production gap but also lays the groundwork for future selection and breeding efforts. By exploring the antioxidant capacity of these plants under Armenian conditions, the study contributes to a better understanding of their potential use in functional food development and health-oriented agriculture.

**Methodology.**

**Plant Material and Extraction.** The aerial parts of *Hyssopus officinalis* and *Dracocephalum moldavica* were harvested during the flowering stage. The collected plant materials were air-dried at room temperature, away from direct sunlight, and then ground into a

fine powder. Extraction was performed by macerating the powdered plant material in 70% methanol at room temperature for 24–48 hours. The mixtures were filtered, and the filtrates were concentrated by evaporating the solvent under reduced pressure to obtain the crude methanolic extracts (Fathiazad et al., 2011).

**DPPH Radical-Scavenging Assay.** The antioxidant activity of the extracts was assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical-scavenging assay (Cos et al., 2000). Extract solutions were prepared in methanol at three concentrations: 50, 100, and 200 µg/mL. To each 1 mL of extract solution, 1 mL of 0.1 mM DPPH methanolic solution was added. The mixtures were incubated in the dark at room temperature for 30 minutes, and the absorbance was then measured at 517 nm using a Cary 60 UV-Vis spectrophotometer. Methanol was used as a blank, and Rutin served as a positive control (Hudz et al., 2021). The radical-scavenging activity was calculated as a percentage of DPPH inhibition (Gulcin & Alwasel, 2023). All antioxidant activity measurements were performed in triplicate, and results are expressed as mean ± standard deviation (SD).

**Results.** The antioxidant activity of methanolic extracts from three varieties each of *H.officinalis* and *D. moldavica* was evaluated using the DPPH radical-scavenging assay at concentrations of 50, 100, and 200 µg/mL. All tested extracts demonstrated a concentration-dependent increase in free radical-scavenging activity.

Among the *Hyssopus officinalis* varieties, the highest scavenging effect at 200 µg/mL was observed in Accord with an inhibition percentage of 78.5%. This was followed by Inej and Lazur', which showed moderate to lower activity, reaching 65.2% and 54.7%, respectively (Table 1).

Table 1.

DPPH Radical-Scavenging Activity (%) of hyssop varieties extracts at different concentrations, (mean ± SD, n=3)

| Variety | 50 µg/mL | 100 µg/mL | 200 µg/mL |
|---|---|---|---|
| Accord | 42.3 ± 2.1 | 61.8 ± 3.0 | 78.5 ± 1.8 |
| Inej | 35.7 ± 1.9 | 53.4 ± 2.7 | 65.2 ± 2.0 |
| Lazur' | 28.9 ± 2.5 | 44.3 ± 3.1 | 54.7 ± 1.6 |

For *Dracocephalum moldavica,* variety Gorynych exhibited the strongest antioxidant activity at all tested concentrations, reaching 85.3% inhibition at 200 µg/mL. Varieties Ametist and Moldavia showed slightly lower activities, with 74.9% and 62.4% inhibition, respectively (Table 2).

Table 2.

DPPH Radical-Scavenging Activity (%) of Moldavian dragonhead varieties extracts at different concentrations, (mean ± SD, n=3)

| Variety | 50 µg/mL | 100 µg/mL | 200 µg/mL |
|---|---|---|---|
| Gorynych | 48.1 ± 1.8 | 68.9 ± 2.4 | 85.3 ± 2.2 |
| Ametist | 41.5 ± 2.0 | 59.6 ± 2.9 | 74.9 ± 1.7 |
| Moldavia | 33.2 ± 1.7 | 50.1 ± 2.6 | 62.4 ± 2.3 |

The DPPH assay results demonstrated clear differences in antioxidant activity among the tested varieties of *Hyssopus officinalis* and *Dracocephalum moldavica*. When comparing the two species, *D. moldavica* varieties generally showed higher antioxidant activity than those of *H. officinalis*. This may be attributed to species-specific differences in the content and composition of phenolic compounds and other bioactive constituents responsible for radical-scavenging activity. In both species, a concentration-dependent increase in radical-scavenging ability was observed, consistent with the expected behaviour of phenolic-rich extracts.

**Discussion.** Varieties exhibiting higher antioxidant activity also corresponded to those with greater total phenolic, flavonoid, and phenolic acid contents, supporting a strong positive correlation between the levels of these bioactive compounds and antioxidant potential. This reinforces the critical role of phenolics as natural antioxidants contributing to the health-promoting properties of these plants. These results align with previously reported total phenolic, flavonoid, and phenolic acid contents in these varieties (Avagyan et al., 2025). A positive correlation was observed between the antioxidant activity and the concentration of these bioactive compounds, confirming their significant contribution to the radical-scavenging potential of the extracts. Varieties with higher phenolic content exhibited stronger antioxidant effects, consistent with the well-known role of phenolics as natural antioxidants (Avagyan, Brindza et al., 2025). Statistical analysis (ANOVA) indicated that the antioxidant activities varied significantly ($p < 0.05$) among the varieties within each species This confirms that genetic variation among varieties influences their radical-scavenging potential.

The observed variability among varieties highlights the importance of selecting specific genotypes for breeding and cultivation aimed at enhancing the antioxidant capacity of plant-derived products. These findings provide a valuable foundation for further phytochemical characterization and bioactivity-guided isolation of active compounds.

The antioxidant activity values obtained in this study are generally in line with previously published data on *Hyssopus officinalis* and *Dracocephalum moldavica* extracts, although slight variations were observed. In some cases, the recorded activity was higher

or lower than reported in other studies, which can likely be attributed to differences in environmental and climatic conditions, such as altitude, temperature, and soil composition, influencing the accumulation of phenolic compounds in the plant material (Gharakhani-Beni et al., 2022; Skrypnik et al., 2022, Povilaityté et al., 2001; Adelnina et al., 2024). These factors are known to affect secondary metabolite production and may explain the observed variability between studies.

Importantly, this study represents the first evaluation of antioxidant activity in *H. officinalis* and *D. moldavica* varieties cultivated under the environmental conditions of Armenia. Moreover, while a number of previous publications focus on wild-growing populations, data on selected breeding varieties remain scarce. This highlights the novelty of the present findings and emphasizes the importance of further characterizing cultivated varieties with potential for use in functional foods and health-promoting applications.

Overall, the findings suggest that selected varieties, particularly variety Accord of *Hyssopus officinalis* and variety Gorynych of *Dracocephalum moldavica*, may serve as promising candidates for use in functional food formulations due to their high antioxidant potential. Further studies focusing on isolation and identification of specific active compounds could provide deeper insights into the mechanisms underlying the antioxidant activity observed.

**Conclusion.** This study demonstrated that methanolic extracts of *Hyssopus officinalis* and *Dracocephalum moldavica* varieties possess notable antioxidant activity, which increased with extract concentration. The observed differences in antioxidant potential among varieties were closely related to their total phenolic, flavonoid, and phenolic acid contents. Notably, *D. moldavica* varieties generally exhibited stronger radical-scavenging activity compared to *H. officinalis*. Overall, the studied varieties, especially those with the highest antioxidant activity, are promising candidates for incorporation into functional foods and nutraceutical formulations. Future work could focus on evaluating other antioxidant mechanisms, such as metal chelation and reducing power assays, as well as in vivo studies to confirm the health benefits.

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**References**

1. Adelnina N, Mosavi Dehmordi L, Amini Chermahini M, Sori M. (2024) Antioxidant and Immunological Properties of Dracocephalum moldavica Extract in Penaeus vannamei. Natural Product Communications. 19(10). https://doi.org/10.1177/1934578X241289253

2. Avagyan A., Brindza J., Horčinová Sedláčková V., Tadevosyan L., Martirosyan G., Harutyunyan *M.*, Hovhannisyan M. (2025). Variation of Biologically Active Compounds in Three Introduced Dracocephalum moldavica L. Varieties under the Valley Conditions of Armenia. European Journal of Ecology, Biology and Agriculture, 2 (3)

3. Avagyan A., Horčinová Sedláčková V., Tadevosyan L., Martirosyan G. (2025) Biologically Active Compounds in Hyssopus officinalis: Comparative Analysis of Three Introduced Varieties Under the Conditions of Armenia. The scientific heritage, No 160: 3-6 https://doi.org/10.5281/zenodo.15362487

4. Atazhanova G, Ishmuratova M, Levaya Y, Smagulov M, Lakomkina Y. (2024) The Genus Hyssopus: Traditional Use, Phytochemicals and Pharmacological Properties. Plants. 13(12):1683. https://doi.org/10.3390/plants13121683

5. Cos P., Calomme M., Pieters L., Vlietinck A.J., Vanden Berghe D. (2020) Structure-Activity Relationship of Flavonoids as Antioxidant and Pro-Oxidant Compounds, Studies in Natural Products Chemistry, Elsevier, v. 22, Part C, p. 307-341, https://doi.org/10.1016/S1572-5995(00)80029-0.

6. Fathiazad F, Mazandarani M, Hamedeyazdan S. (2011) Phytochemical analysis and antioxidant activity of Hyssopus officinalis L. from Iran. Adv Pharm Bull. 1(2):63-7. https://doi.org/ 10.5681/apb.2011.009.

7. Flora of Armenia (1987) Institute of Botany, Yerevan, v. 8, 419p. (in Russian)

8. Gawdiya S., Sharma R.K., Singh H. *et al.* (2025) Crop diversification as a cornerstone for sustainable agroecosystems: tackling biodiversity loss and global food system challenges. Discov Appl Sci 7, 373. https://doi.org/10.1007/s42452-025-06855-z

9. Gharakhani-Beni, A., Ghasemi Pirbalouti, A., Javanmard, H., Soleymani, A., & Golparvar, A. (2022). Chemical compositions, yield and antioxidant activity of the essential oil of hyssop (*Hyssopus officinalis* L.) under intercropping with fenugreek (*Trigonella foenum-graecum* L.). Natural Product Research, 37(4), 675–680. https://doi.org/10.1080/14786419.2022.2078971

10. Gulcin, İ., Alwasel, S. H. (2023). DPPH Radical Scavenging Assay. Processes, 11(8), 2248. https://doi.org/10.3390/pr11082248

11. Hudz, N., Horčinová Sedláčková, V., Yezerska, O. ., Zhurba, M. ., & Brindza, J. (2021). Methodological Approach to the Elaboration of the Analytical Procedure of the Antioxidant Activity Determination of the Schisandra chinensis (Turcz) Baill. Extracts. Agrobiodiversity for Improving Nutrition, Health and Life Quality, 5(2). https://doi.org/10.15414/ainhlq.2021.0024

12. Kozłowicz K, Nazarewicz S, Różyło R, Nastaj M, Parafiniuk S, Szmigielski M, Bieńczak A, Kozłowicz N. (2021) The Use of Moldavian Dragonhead Bagasse in Shaping the Thermophysical and

Physicochemical Properties of Ice Cream. Applied Sciences. 11(18):8598. https://doi.org/10.3390/app11188598

13. Peredo Parada, S., & Barrera Salas, C. (2024). Multifunctional Plants: Ecosystem Services and Undervalued Knowledge of Biocultural Diversity in Rural Communities - Local Initiatives for Agroecological Transition in Chile. Land, 13(1), 39. https://doi.org/10.3390/land13010039

14. Povilaityté V., Cuvelier M.-E., Berset C. (2001) Antioxidant properties of Moldavian dragonhead (Dracocephalum moldavica L.). Journal of Food Lipids, 8 (1): 45-64

15. Skrypnik L., Feduraev P., Styran T. et al. (2022) Biomass, Phenolic Compounds, Essential Oil Content, and Antioxidant Properties of Hyssop (Hyssopus officinalis L.) Grown in Hydroponics as Affected by Treatment Type and Selenium Concentration. Horticulturae 2022, 8, 1037. https://doi.org/10.3390/ horticulturae8111037