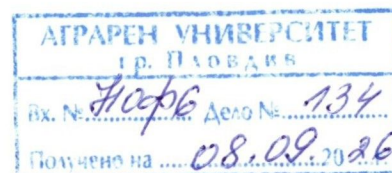


SCIENTIFIC OPINION



on the PhD Thesis for the award of the educational and scientific degree "PhD" in the field of Higher Education 4. Natural Sciences, Mathematics and Informatics, Professional Field 4.4. Earth Sciences, Scientific Speciality Ecology and Ecosystem Protection.

Author of the PhD Thesis:

Maria Radkova Ihtyarova, part-time PhD student at the Department of "Chemistry, Phytopharmacy, Ecology and Environmental Protection" at the Agricultural University, Plovdiv

Topic of the dissertation:

"Phytoremediation of soils contaminated with heavy metals, with plants from the Asteracea family"

Prepared the Opinion: Prof. Diana Atanasova Kirin, PhD, Agricultural University - Plovdiv, Field of Higher Education 4. Natural Sciences, Mathematics and Informatics, Professional Field 4.4. Earth Sciences, the scientific specialty Ecology and Ecosystem Protection, appointed as a member of the scientific jury by Order No. RD 16-809/29.06.2026 by the Rector of the Agricultural University - Plovdiv.

1. Relevance of the problem.

The basis of the scientific research is phytopharmacy, a modern and promising scientific direction for addressing a number of problems related to soil pollution. The PhD student, under the guidance of her scientific supervisor, develops and applies various approaches to clean and restore soils contaminated with heavy metals, using phytomediator plants from the family Asteraceae. The developed topic and the scientific research work performed are relevant, promising and of economic significance.

2. Purpose, tasks, hypotheses and research methods.

The main goal of the PhD Thesis is to carry out a comprehensive assessment of the behavior of the heavy metals Pb, Cd and Zn in the system "soil - plant - essential oils" under conditions of technogenic pollution by studying their bioavailability in the soil, accumulation and translocation in plants, assessing the phytoremediation potential of the studied species and analysing their influence on the chemical composition, quality and safety of the obtained essential oils. To achieve the set goal, seven tasks have been clearly, accurately and adequately formulated. Based on the analysis of the literature data and existing scientific concepts on the behaviour of heavy metals in the "soil - plant" system and their influence on the synthesis of secondary metabolites, 5 working hypotheses have been presented.

3. Visualisation and presentation of the obtained results.

The PhD Thesis is 158 pages long. The list of used literature, including 241 literary sources, of which 7 are in Bulgarian, and 234 are in English, is located on 12 pages. The specified volume also includes 5 appendices totalling 9 pages. The work is illustrated with 21 tables, 11 figures, and schemes. The PhD work is designed in accordance with the requirements for this type of scientific work. The PhD Thesis includes the following main sections: Introduction – 2 pages; Chapter 1 - Literature review – 24 pages; Chapter 2 – Purpose, tasks and working hypotheses – 2 pages; Chapter 3 - Material and methods of the experimental study – 18 pages; Chapter 4 - Results and discussion – 83 pages; Chapter 5 – General conclusions, inferences, contributions and recommendations – 3 pages.

4. Discussion of the results and used literature.

The results of the study include results, analyses and assessments of soil conditions, elemental composition, phytoremediation potential and tolerance, studies of essential oils, heavy metals, terpene profile and chemotypic affiliation of the studied plants. A large volume of scientific literature has been processed in relation to the topic of the dissertation.

5. Contributions of the dissertation work.

The results obtained from the scientific research have given the doctoral student and her scientific supervisor the basis to formulate the following scientific and Scientific-Applied contributions:

Scientific contributions

1. Clearly expressed species and organ-specific accumulation of lead, cadmium and zinc has been established in plants of the Asteraceae family, grown under conditions of industrial pollution. 2. Dependencies have been established between the accumulation of lead, cadmium and zinc and the distribution of micro- and macroelements in the various organs of plants, which is important for the mineral nutrition and adaptation of plants in conditions of heavy metal pollution. 3. A classification of the studied plant species has been developed according to their ability to absorb, translocate and accumulate heavy metals, which allows a comparative assessment of their phytoremediation potential. 4. A conceptual model of a "double selective filter", a joint action of physiological barrier mechanisms and selectivity of the distillation process, has been developed, which explains the limited transfer of heavy metals to the essential oils produced from them. 5. It has been established that contamination with lead, cadmium and zinc does not violate the chemotypic affiliation of the essential oils, but is associated with quantitative changes in the terpene profile without loss of chemical identity.

Scientific and applied contributions

1. Plant species from the Asteraceae family with phytoremediation potential have been identified, which is the basis for their application in technologies for stabilisation and/or extraction of heavy metals from contaminated soils. 2. The safety of essential oils obtained from plants grown on soils contaminated with heavy metals has been assessed, and it has been established that high concentrations of lead, cadmium and zinc in the soil and plant biomass do not lead to contamination of the final product. 3. Practical guidelines for the use of plants from the Asteraceae family on contaminated sites are proposed, combining the ecological restoration of soils with the production of pharmacologically valuable products. 4. An applicable conceptual model for assessing the risk and potential of plant systems in polluted environments is proposed, which can be used as a methodological basis for planning ecological, agroecological and phytotechnological interventions.

6. Critical notes and questions.

I recommend that the research be continued.

7. Published articles and citations.

The PhD student Maria Ihtyarova has presented five publications in connection with the research on her PhD Thesis (one in press), co-authored with her scientific supervisor, with which she fully meets the requirements for scientific production and verification in NACID. The PhD student also presents a list of 4 citations. The presented abstract objectively reflects the structure and content of the PhD Thesis.

CONCLUSION:

Based on the various research methods learned and applied by the PhD student, the correctly conducted experiments, the generalizations and conclusions made, I believe that the presented PhD Thesis meets the requirements of the Law on the State of the Republic of Bulgaria and the Regulations of the Agrarian University for its application, which gives me reason to evaluate it POSITIVELY.

I would like to propose that the esteemed Scientific Jury also vote positively and award the part-time doctoral student Maria Radkova Ihtyarova the educational and scientific degree of "doctor" in the scientific specialty Ecology and Ecosystem Protection.

Date: 30.08.2026

City of Plovdiv

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