REVIEW

On PhD Thesis for for obtaining the scientific degree "Doctor" in: Professional field 4.4. Earth Sciences, Scientific specialty "Ecology and Ecosystem Conservation"

Author of the PhD Thesis: Desislava Gospodinova Angelova, part-time PhD student at the Department of Microbiology and Ecological Biotechnology at the Agricultural University, Plovdiv

Title of the PhD Thesis: Utilization of wastewater sludge from treatment plants by composting and vermicomposting

Reviewer: Assoc. Prof., PhD, DSc Dilian Georgiev Georgiev. Scientific specialty: Associate Professor and PhD in the field of higher education 4. Natural sciences, mathematics and informatics in professional field 4.3. Biological sciences (Ecology and ecosystem conservation); DSc in professional field 4. Natural sciences, mathematics and informatics in professional field 4.3. Biological Sciences (Zoology)

appointed a member of the scientific jury by order № РД-16-1173/20.10.2021 of the Rector of AU.

1. Brief introduction of the candidate.

Born on 02.04.1982. Education and training: Bachelor's degree in Ecology and Environmental Conservation; two master's degrees: Plant Protection and Ornamental Plants and Landscape Design. All degrees successfully completed at the Agricultural University - Plovdiv. She worked in the following positions: Agrochemistry and Plant Protection Technician, ET MIKA-90, Plovdiv (02.2009 - 07.2009); Ecologist, Bulplod Ltd., Plovdiv (08.2012 - 05.2021); Ecologist, Bulver EOOD, Plovdiv (04.2018 - until now). Enrolled as a part-time doctoral student at the Department of Microbiology and Ecological Biotechnology at the Agricultural University, Plovdiv since February 26, 2014.

2. Relevance of the topic.

As a result of the development of industry and the increase in the number of people on Earth, a huge amount of waste of all kinds is generated in the environment. Improper management of this waste poses real risks both to the environment and to public health. Various treatment methods are used in practice to limit these risks. One of them is composting, which is widely used and ongoing in the world and the European Union. In addition to helping to treat waste, composting also plays an important role in agricultural production. The topic of the dissertation is relevant and

helps to expand our knowledge in this field of science and practice.

3. Aim, tasks, hypotheses and research methods.

The dissertation is written on 273 pages and contains 38 tables and 97 figures. This is an impressive, significant volume.

The aim of the dissertation is set adequately and is realistically feasible: "Optimizing the utilization of sludge from urban wastewater treatment plants by composting and vermicomposting and turning them into a product useful for agriculture and the environment." The tasks (four in number) set for the implementation of this goal are correctly selected and chronologically arranged.

The hypothesis of the dissertation is correctly formulated and then developed in the chapter presenting the results of the research. The doctoral student is familiar with the issue and has selected adequate research methods.

The methodology of the work is specific and correct. It has been applied accurately and for that the respective set and significant results have been achieved. Experiments with plant test objects have been set, a large amount of raw data has been accumulated, which have been adequately and accurately analyzed by mathematical and statistical methods.

4. Presentation of the obtained results.

I highly appreciate the original results of the dissertation, which contribute significantly to the knowledge and application of composting and vermicornposting in the treatment of sludge from wastewater treatment plants. The results are well arranged in the work, illustrated with many figures and tables. Their quantity and quality is sufficient for this type of dissertation.

I consider the results to be completely sufficient for a dissertation in a professional field 4.4. Earth Sciences, Scientific specialty "Ecology and Ecosystem Conservation".

5. Discussion of the results obtained and references.

The discussion of the obtained results is done in two main aspects - comparison with already known, published materials and building on them. The differences and similarities of the obtained results and those in the literature are discussed.

Chapter "References" includes 481 sources, of which 9 in Cyrillic and 472 in Latin. This is a significant amount of information that the doctoral student has worked with and analyzed. Shows her excellent knowledge of the relevant issues.

6. Contributions of the dissertation.

The contributions of the dissertation are seven in number: four scientific and three scientific-applied.

Scientific contributions

I appreciate the contributions of the dissertation, which are original and are in the field of environmental protection and agriculture. For the first time approaches and methodologies have been applied, others have been adapted to the respective situation:

1. For the first time in Bulgaria a complex study of the treatment of wastewater sludge by composting and vermicomposting was made.
2. Models have been prepared for utilization of wastewater sludge in agriculture, landscaping and for reclamation of disturbed terrains.
3. An approach has been established to reduce the concentration of heavy metals resulting from wastewater sludge in joint treatment, so as to obtain a final product meeting the requirements set out in the Ordinance on separate collection of biowaste and treatment of biodegradable waste from 2017.
4. A way has been established to reduce the loss of organogenic elements in the final products by returning the infiltrate to the system by dew, in sediments with low content of heavy metals.

Scientific-applied contributions

Like the scientific contributions, this type of contribution to the dissertation emphasizes its importance and significance. Again, adapting methodologies and applying new approaches, developing technologies:

1. An improvement has been made in the technology of vermicomposting, as instead of the so-called beds the use of composters has been applied.
2. The effect of the principles of the circular economy is demonstrated through the recycling of production waste and their conversion into final products compost and vermicompost applied in agriculture.
3. The composted sludge amounts to about 1050 t per year, and the obtained in-situ vermicomposts meet the requirements for compost product set in the Ordinance for separate collection of biowaste and treatment of biodegradable waste from 2017 and are used as a quality complex fertilizer for maintaining green areas.

7. Critical notes and questions.

I have no critical remarks or questions to the PhD student.

8. Публикувани статии и цитирания.

The publications are sufficient in number (4) and are in accordance with the requirements of the law for development of the academic staff of the Republic of Bulgaria. They have been published in prestigious scientific journals. They clearly show the personal contribution of the PhD student and her work on the issue:

1. D. Angelova, St. Shilev, 2016. Evaluation of joint composting of sludge from WWTP and biodegradable waste from parks to meet the requirements for recovery in agriculture. Collection of reports from "Ecology and Health" June 9-10, 2016, pp. 429-434, (in Bulgarian) ISSN 2367-9530, http://hst.bg/bulgarian/
2. Angelova D., Shilev, S., Naydenov, M. 2016. Composting of sewage sludge at

large scale for subsequent utilization in agriculture. In: (Filcheva, Stefanova, Ilieva eds). 4th Nat. conf. of BHSS. 8-10 Sept. 2016, Sofia, ISBN 978-619-90189-2-7, 285-295.

3. Shilev S., Azaizeh H., Angelova D. 2019. Biological treatment: a response to the accumulation of biosolids. pp. 149-178. In: Singh, D. P., Gupta, V. K., Prabha, R. (Eds.) Microbial Interventions in Agriculture and Environment, Vol. 2: Rhizosphere, Microbiome and Agroecology. Springer Singapure. doi: 10.1007/978-981-13-8383-0.

4. Angelova D., S. Shilev S. 2021. Composting and vermicomposting of biosolids for utilization in agriculture. Journal of Environmental Protection and Ecology 22 (3), 1030–1039.

The presented abstract (summary) objectively reflects the structure and content of the dissertation.

6. CONCLUSION:

Based on the different research methods learned and applied by the PhD student, the correctly performed experiments, the summaries and conclusions made, I believe that the presented dissertation meets the requirements of the law for development of the academic staff of the Republic of Bulgaria and the Regulations of the Agricultural University for its application, which gives me reason to evaluate it POSITIVE.

I suggest to the esteemed Scientific Jury also to vote positively and to award / not to award Desislava Gospodinova Angelova the scientific degree "Doctor" in a professional field 4.4. Earth Sciences, Scientific specialty "Ecology and Ecosystem Conservation"

17.11.2021
Plovdiv