WARSAW
UNIVERSITY
OF LIFE SCIENCES

dr hab. inż. Maja Radziemska, prof. SGGW
Institute of Environmental Engineering
Warsaw University of Life Sciences - SGGW
Nowoursynowska 159
02-776 Warsaw

Warsaw, 8.11.2022 r.

REVIEW

of the doctoral dissertation of mgr inż. Danuta Drożdż
„Production and use of organic soil enhancers and growing media from agro-residues"

Dissertation advisor: prof. dr Erik Meers
Dissertation co-advisor: dr hab. inż. Krystyna Malińska, prof. PCz

Formal basis for carrying out the review

The review was prepared on request on of the Chairwomen of the Council of the Scientific Discipline of *Environmental Engineering, Mining and Energy* of the Częstochowa University of Technology, dr hab. inż. Iwona Zawieja, prof. PCz (Act No. 93/2021/2022 of 26.09.2022). The opinion was prepared based on the statutory requirements specified in par. 13 of the Act of 14 March 2003 Law on Academic Degrees and Titles and Degrees and Title in the Arts (Journal of Laws No. 65, item 595 as amended).

Candidate description

Mgr inż. Danuta Drożdż graduated from the Częstochowa University of Technology in 2017 obtaining a master's degree in industrial bioengineering. The PhD candidate has never before applied for a doctoral degree. She gained professional experience during 4 scientific internships within the country and abroad. Moreover, she took part in a 4-week scientific internship at the

Water Supply and Sewerage Joint Stock Company of the Częstochowa District as well as the Bury & Bury Patent Office (Warsaw, Poland). Next, in the year 2019 and 2021, she spent a total of 21 weeks at the University of Ghent (Gent, Belgium). The candidate participated as a Research assistant in two Horizon 2020 projects (Nutri2Cycle and Organic+). She deepened her knowledge of Solid Waste Management and safe agriculture when participating in courses at Universities in Greece and Belgium in 2019 and 2021. The candidate is the coauthor of 8 scientific publications. The above-presented facts substantiate mgr inż. Danuta Drożdż as a specialist in the scope of environmental engineering and biotechnology. The educations gained over the course of undergraduate and postgraduate studies provide her with a solid substantive and methodological basis for preparing the assessed doctoral dissertation, which was carried out as part of doctorate studies in the Department of Infrastructure and Environment at the Częstochowa University of Technology, which the Candidate commenced in 2018.

Merit and topicality of the assumed topic

The dissertation of Danuta Drożdż submitted for review covers issues of utilizing poultry manure as well as the possibility of obtaining fertilizer products which can be applied when farming crops on soils that lack organic matter. Moving on to the analysis of the choice of research topic as regards its merit, I believe that the results presented in the dissertation combine both cognitive as well as practical aspects. The assumed research topic is an important and topical scientific problem, especially in regards to studies on poultry manure, its properties, means of its management and influence on the natural environment. Particular attention was given to issues connected with the emissions of gases from fresh poultry manure as well as means their limitation. Research problems contained in the Dissertation pertain to three issues indicated by the PhD candidate 1: an analysis of the state of knowledge by a study of available literature, 2: analysis of the properties of poultry manure from caged hens, 3: laboratory processing of poultry manure in drying processes, pyrolysis and composing, 4: analysis of the properties of products obtained from poultry manure in terms of its application in the fertilization of soil, 5: analysis of element cycles (C, N and P) under laboratory composing of poultry manure, and 6: assessing the influence of obtained soil improvers on soil properties as

well as plant growth. I affirm that the choice of research topic is well-founded and fully warranted by the newest scientific achievements and practical needs.

Characteristics and Substantive Assessment

The dissertation presented for assessment is characterized by a clear and logical structure. Its individual chapters, divided into a part containing the literary review and research section, retain a cause-effect structure and reflect the chosen research process. The main contents of the Dissertation are presented in 6 main chapters, taking care to preserve the right proportions. The research content is in accordance with the title, and that of chapters – with their headings, which provide a synthetic overview of the substantive content. The title of the dissertation is clear, communicative and appropriate in regards to the presented contents. The work numbers 106 pages of fundamental text, contains 38 tables and 22 figures. A glossary of abbreviations as well as terminology used within the text, a table of figures and tables as well as a summary in Polish, English and Dutch have also been included. The dissertation numbers 383 literature positions, among which 146 works that have been published in the last 5 years deserve attention. There were 22 publications in Polish and 300 in English, with the rest being standards and references to internet websites, which were carefully selected to coincide with the presented research problem. The PhD candidate is the coauthor in 5 of the mentioned works. The dissertation finishes with a summary and findings which conclude the carried out research. Taking the above into account, I believe that the structure of the doctoral dissertation of mgr inż. Danuta Drożdż is correct and in accordance with the research concept. The author, within the 59 typed pages, presents contents introducing the topic of the dissertation, describing the characteristics of organic soil enhancers and growing media (types and functions of organic soil enhancers). Moreover, it includes information on the effects of organic soil enhancers on soil properties. The candidate touches on issues connected with legal and environmental aspects; poultry manure as a resource for the production of organic soil enhancers, generation and characteristics, environmental risks, and methods for processing related to the use of poultry manures. The theoretical introduction indicates familiarity with issues connected with the research carried out by the PhD candidate.

Rusch

The research section focuses on determining the genesis of the choice of research topic, determining the aim and scope of the research, as well as the scheme and application of research methods. Here, one must agree with the Author who noticed that there is great potential and need to investigate the potential of poultry manure as a resource for the production of organic soil enhancers and to determine their physicochemical properties and effects on the soil properties and plant growth. The above prompted the PhD candidate to define the main scope of the work: 1)Assessment of the potential of using poultry manure derived biochar produced at 3 different pyrolysis temperatures as a soil enhancer. (2) Comparison of the investigated soil enhancers (i.e., dried poultry manure, poultry manure derived biochar and poultry manure derived compost) and their effects on soil properties and plant growth. (3) Analysis of the C, N, P cycles during laboratory composting of poultry manure and wheat straw used as a bulking agent.

The results of the research along with their analysis is presented by the PhD candidate in Chapter 5, along with a division into 5 main subchapters where the properties and fertilizing potential of poultry manure derived biochar and dried poultry manure are described. Moreover, it presents the research in an adequate manner, along with results pertaining to the assessment of the influence of the obtained soil enhancers on soil properties and the growth of cherry tomatoes. In the next chapter, the candidate focuses on determining the nutrient recovery during the composing process of poultry manure. Chapter 6 of the present dissertation contains 10 substantive conclusions as well as elements connected with summarizing the carried out research tasks. It ought to be noted that the layout of the work, its structure, and the sequence of individual chapters have been well organized and developed. They correspond to the set out aim and scope of the dissertation.

Most important scientific achievements of PhD candidate

The dissertation proved that it is necessary to comprehensively approach the problem of utilizing poultry manure. Drying, pyrolysis and composting can be a good alternative to using solely raw poultry manure for growing corps. The scientific achievement of the PhD candidate are results of studies which prove that: 1: fresh poultry manure used in the research was safer in a microbiological sense and in terms of heavy metal contents. 2: soil enhancers prepared

from poultry manure by composting, pyrolysis and drying where characterized by the following properties: in the first case, composts after 5 months of maturation were characterized by a pH of approximately 8.65. The content of organic matter of the composts was approximately 54%.It was revealed that after 5 months of maturation, the composts were ready to be used as soil enhancers. Moreover, poultry manure derived biochar had too high of a pH value, amounting to approximately 12.5 units. Drying the manure led to the lowering of the pH by 0.5 units when compared to raw poultry manure, with the moisture content decreasing by 93% and organic matter content by 8%.

An important element which dealt with by the dissertation are the results of studies involving the determination of nitrogen, phosphorus and carbon cycles in the process of poultry manure composing, and the losses that are observed during the process. Here it should be mentioned that the majority of studies which are carried out in this scope focus only on gas emissions, while ignoring the by-products of compositing, such as leachate and condensate. As had been rightfully noticed by the PhD candidate, it is recommended to determine the carbon, nitrogen and phosphorus cycles during the composting process both in terms of the input products and output products, but also the leachate and condensate. Thanks to the review of literature, the PhD candidate planned the realization of the assumed research task in a correct manner, and carried out the necessary research along with preparing and analyzing results. She thus proved her maturity and independence in solving such research problems. The results presented in the dissertation can serve as the basis for achieving further scientific progress and practical application.

Detailed remarks and discussion

When familiarizing myself with the contents of the dissertation, a few general questions arise:

- Please indicate which of the soil enhancers analyzed in the works can be regarded as the most advantageous in terms of soil properties and plant growth.
- Please indicate the application areas of protection and environmental engineering of the investigated additives.

Moreover, when reading the dissertation, the following detailed remarks arise:

- Page 87 mentions the quality requirements for biochar input into the soil, the content of heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn); As, on the other hand, is considered a metalloid according to nomenclature.
- I recommend replacement of the term "heavy metals" with scientifically defensible terms like "potentially toxic element", "trace metal element".
- According to which classification is the soil texture determined ?
- A few important aspects of information are missing in the materials and methods section: how many repetitions were carried out for the plant growing experiment, what water was used to water the plants, at what level was the moisture content of the soil maintained over the course of the experiment, how long did the experiment last.
- In the Reviewer's opinion, the text is missing information about the reason behind choosing cherry tomatoes as the tested plant.

While the above critical remarks can be later applied when preparing the text for publication, I do not believe them to decrease the value of the present dissertation.

Final Assessment

I thus affirm that the presented doctoral dissertation of PhD candidate Danuta Drożdż M.Sc. titled "Production and use of organic soil enhancers and growing media from agro-residues" fulfills the formal and customary requirements set forth for doctoral dissertations in the Act of 14 March 2003 Law on Academic Degrees and Titles and Degrees and Title in the Arts. The reviewed doctorial dissertation is also in accordance with Art. 187 of the Act of 20 July 2018 on the Law on Higher Education and Science, which states that:

1. The doctoral dissertation presents general theoretical knowledge of the candidate in the discipline or disciplines as well as the ability to independently carry out scientific or artistic work.

2. The topic of the doctoral dissertation is an original solution to a scientific problem, an original solution in terms of applying the results of own scientific research in the economic or social sphere, or an original artistic accomplishment.

Taking into account the above as well as my positive assessment of the doctoral dissertation in terms of the possessed theoretical and practical knowledge, the specificity of the

issues under research, the ability to interpret results and the appropriate application of terms and names along with specialist terminology, I confirm that mgr inż. Danuta Drożdż possesses the ability to independently conduct scientific research in the field of engineering and technical studies.

I hereby call for the Council of the Science Discipline of Environmental Engineering, Mining and Energy to admit mgr inż. Danuta Drożdż to subsequent stages of the doctoral programme.

Dr hab. inż. Maja Radziemska, prof. SGGW