

**REVIEW**

of Ph.D. thesis for the acquisition of:

educational and scientific degree " <b>doctor</b> "	<b>X</b>
scientific degree " <b>Doctor of Science</b> "	
	the true is indicated by the sign "X"

**Author of the dissertation:**

Assist. Prof.		Yoana	Dinkova	Stoyanova	UCTM
academic position	scientific degree	name	middle name	last name	workplace

**Topic of the dissertation:**

Waste products from the essential oil industry – utilization and biological activity
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**Scientific area:**

5	Technical Sciences
code	name

**Professional area:**

5.11	Biotechnology
code	name

**Scientific specialty:**

Technology of biologically active compounds
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**The review was written by:**

Prof.	Dr.	Dancho	Lyubenov	Danalev	UCTM
academic position	scientific degree	name	middle name	last name	workplace

**1. Completion of the provided documents:**

A) The dissertation and the competition documents are in full compliance with the Regulations.	4 points	<b>X</b>
B) The documents are complete but do not fully comply with the requirements of the Regulations.	2 points	
C) The documents are not completed in accordance with the requirements of the Regulations.	0 points	

		one of the answers given is marked with the sign "X"
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Missing documents and violated standards must be described if response C is marked.

The candidate for the acquisition of the educational and scientific degree "Doctor" in the professional direction 5.11. Biotechnology under the doctoral program Technology of Biologically Active Substances has completed her bachelor's degree in Fine Organic Synthesis, and the "Master" degree in the specialty "Biomedical Engineering" at the University of Chemical Technology and Metallurgy. A natural continuation of her development is the preparation of the Ph.D. thesis in the Biotechnology professional direction and deepening her knowledge, skills and competencies in the claimed professional direction. Since 2023 to the present, she holds the academic position of assistant professor in the Department of Biotechnology of the University of Chemical Technology and Metallurgy, which shows her ambition and desire to develop as a scientist in the claimed scientific field.

According to the requirements published on the website of the University of Chemical Technology and Metallurgy, candidates for the acquisition of the Ph.D. degree are required to submit the following documents: an application to the Rector in a defined form, a CV, a notarized higher education diploma, orders for enrollment and expulsion of the doctoral student, exam protocols from exams taken under the Individual plan of the doctoral student, a list of publications on the topic of the dissertation, Ph.D. thesis, declaration of authorship, an abstract of the dissertation in Bulgarian and English and copies of publications on the topic of the dissertation.

All of the listed documents were submitted by the doctoral student in their entirety and on time.

## 2. Meeting the minimum requirements under the Regulations:

A) The candidate meets the minimum requirements	20 points	<b>X</b>
B) The candidate doesn't meet the minimum requirements	0 points	
		one of the answers given is marked with the sign "X"

It must be filled in if answer B is marked. The publication activity of the candidate is analyzed. The response of the results achieved (quoted) is analyzed.

According to the regulatory rules of the Act for development of the academic staff of the Republic of Bulgaria, the candidate for the Ph.D. degree in the pretended field must successfully pass the exams planned in the Individual plan, carry out the necessary scientific research activity and cover the required minimum of 30 points of the publication activity. The contribution of publications is distributed according to the Appendices of the Act for development of the academic staff of the Republic of Bulgaria as follows: Scientific publication (article or report), published in editions that are referenced and indexed in world-renowned databases with scientific information: 40/n (where n is the number of authors) or distributed in proportion based on the contribution protocol. Doctoral student Yoana Stoyanova presents 3 articles referenced in the world databases Scopus and WoS as follows:

1. N. Lazarova-Zdravkova, D. Tsanova, Y. Stoyanova, Ch. Chilev, N. Georgieva, D. Peshev. Study of the biological activity of essential oils-water mixtures. Food Science and Applied Biotechnology. 2021, 4(1), 48-56. (Q3, SJR 0.22), <https://doi.org/10.30721/fsab2021.v4.i1.130>

2. Y. Stoyanova, N. Lazarova-Zdravkova, D. Peshev. Valorisation via nanofiltration of the antioxidant residual water from industrial hydrodistillation of Rosa Damascena mill. Petals. Journal of Chemical Technology and Metallurgy. 2025, 60(1), 3-10. (Q3, SJR 0.19), <https://doi.org/10.59957/jctm.v60.i1.2025.1>

3. Y. Stoyanova, N. Lazarova-Zdravkova, Dimitar Peshev. Is Membrane Filtration Applicable for the Recovery of Biologically Active Substances from Spent Lavender? Membranes. 2025, 15, 21. (Q2, IF 3.3) <https://doi.org/10.3390/membranes15010021>

with a total point asset of 30 points, which fully meets the requirements of the Act for development of the academic staff of the Republic of Bulgaria. In two of the publications, the doctoral student is the first author, and in one, the third, which undoubtedly shows her overall contribution to the developments presented to the scientific community.

**3. The relevance of the topic of the dissertation:**

A) The topic is relevant and new (there are no known results on the topic by other authors)	8 points	
B) The topic is relevant and results from other authors are known	6 points	<b>X</b>
C) The topic is not relevant, but results from other authors are known	2 points	
D) The topic is not relevant and no results from other authors are known	1 point	
E) The topic does not correspond to the level of dissertation	0 points	
		one of the answers given is marked with the sign "X"

The evaluation of the relevance of the dissertation must be substantiated

The waste generated annually from the processing of essential oil crops for the needs of the perfumery, cosmetic, pharmaceutical and food industries is enormous. In Bulgaria, as a leading producer of essential oils in Europe, it is beginning to take on increasingly threatening dimensions. The uncontrolled disposal of these fractions can cause both environmental problems, including soil and water pollution, and loss of valuable biologically active substances in the residual biomass from production. In this context, the work presented by doctoral student Yoana Stoyanova "Waste products from the essential oil industry - utilization and biological activity" is extremely well selected and in accordance with the needs of modern practice. The literature review of the dissertation work is built on 142 literary sources, of which about 1/3 are from the last 10 years, which shows modernity and good interest in the topic on a global scale.

**4. Knowledge of the problems, subject of research in the dissertation:**

A) The doctoral student knows in detail the achievements of other authors on the topic of the dissertation	8 points	<b>X</b>
B) The doctoral student is partially familiar with the achieved results on the topic of the dissertation	4 points	
C) The doctoral student has no prior knowledge of the status of the problems in the dissertation	0 points	
		one of the answers given is marked with the sign "X"

The evaluation must be substantiated if answer C is marked.

As mentioned above, the dissertation is developed on the basis of 142 literary sources, 82% of which are from foreign authors, which undoubtedly shows that the doctoral student is well acquainted with world developments on the topic, and 18% are from Bulgarian authors, which also suggests that the dissertation is consistent with developments on the topic in our country. In addition, the data obtained from other scientists, as well as the doctoral student's own as a result of her development, are systematized and summarized in a large number of figures and tables, which allows them to be very well tracked in the process of developing the doctoral thesis. This extremely well allows the fulfillment of the set goal and tasks of the dissertation to be tracked and shows a very good and in-depth knowledge of the topic being developed by the doctoral student. All research methodologies used are described in extremely detail and in-depth, which will allow their future use by scientists working on the same or similar scientific topics.

**5. Type of research:**

A) Theoretical	4 points	
B) Applied	4 points	
C) Theoretical with application elements	4 points	<b>X</b>
D) It does not correspond to the level of dissertation	0 points	
		one of the answers given is marked with the sign "X"

The level of research must be substantiated if answer D is marked.

The presented Ph.D. thesis includes significant theoretical calculations regarding the extraction of biologically active substances from waste biomass from the essential oil industry, and mathematical models have been proposed describing the possibilities for extracting residual biologically active substances by using different types of nanomembranes. In addition, a number of biological studies of the concentrated extracts have been carried out, including antibacterial and antioxidant activity.

#### 6. Objectives of the research:

A) Realistic and of scientific and / or applied interest	8 points	<b>X</b>
B) Realistic, but not of scientific and / or applied interest	3 points	
C) Unattainable (unrealistic)	0 points	
		one of the answers given is marked with the sign "X"

Objectives must be specified. The type of the set objectives must be justified.

The goal of this dissertation "Investigation of the biological activity of waste products from the production of essential oils of rose, lavender and clove and investigation of the effectiveness of the processes of membrane filtration, spray drying and precipitation as methods for their utilization" is completely realistic and possible to achieve with simultaneous scientific and applied potential. The separate tasks set for its achievement on page 41 of the dissertation are also completely realistic and fully achieved at the end of the work.

#### 7. Methods of research:

A) Adequate to research and set objectives	8 points	<b>X</b>
B) Partially appropriate, enabling part of the scientific objectives and / or applications to be achieved	4 points	
C) Inappropriate methods	0 points	
		one of the answers given is marked with the sign "X"

Methods must be specified. The type of methods used is justified.

In the course of developing the experimental part of the dissertation, the following methods were used for preparation and analysis of the target samples:  
- mixing and homogenization of essential oil and distilled water in a separating funnel for the preparation of solutions mimic hydrosols.

- concentration of biologically active substances by traditional methods of liquid-liquid and liquid-solid phase extraction and by modern membrane filtration of waste fractions from the production of essential oils using several types of commercially available membranes
- spray drying
- precipitation of membrane concentrated extract from waste plant mass
- study of antibacterial activity of waste fractions from the production of essential oils by two methods disk-diffusion and microdilution in broth
- study of antioxidant activity by DPPH method
- study of the chemical composition of waste fractions from the production of essential oils by modern HPLC and GC analyses
- determination of dry matter in an extract of waste plant material

According to the presented descriptions of the methods used in the dissertation work, it can be said that they are undoubtedly modern, were carried out in an appropriate manner to obtain optimal results, and the data obtained from them were analyzed and interpreted in an appropriate manner, being important mathematical models related to membrane filtration and conclusions related to the studied biological activity of concentrates of biologically active substances were derived.

#### 8. Contributions of the dissertation:

A) With lasting scientific and / or applied response, they form the basis for new research and applications	20 points	<b>X</b>
B) They are of significant scientific and / or applied interest, complete and / or summarize previous research	16 points	
C) They are of scientific and / or applied interest	12 points	
D) Lack of significant contributions	8 points	
E) Lack of contributions	0 points	
		one of the answers given is marked with the sign "X"

Contributions must be specified. The type of results achieved must be justified.

As can be seen from the presentation in the dissertation, the doctoral student Yoana Stoyanova has relied for her development on basic knowledge, skills and competencies related to extraction processes and the study of biological activity obtained and accumulated over the years in the departments of Chemical Engineering and Biotechnology of the UCTM. This shows a continuity in the developed topic between her and her scientific supervisors and gives reason to claim that as a continuation of their schools, the current results will be used, and the research will be developed in future developments with the participation of the doctoral student. In addition, she has conducted several specializations in connection with the work and the dissertation at the Technical University of Hamburg-Harburg (TUHH), Germany, where she conducted the research on spray drying reported in the dissertation, which shows that the topic of the dissertation is of interest to Western partners and could serve as a basis for joint developments and projects. The results of the dissertation work have been published in 3 scientific publications, referenced in the world databases Scopus and WoS, which is another attestation of the interest in them and the possibility of their future development. The published results have a direct bearing on the utilization of waste products with a direct impact on environmental protection and the completeness of the use of substances in the field of health care and quality of life.

The contributions of this dissertation work can be summarized in several areas:

- obtaining concentrated solutions of biologically active substances from waste from the essential oil industry by using various modern methods
- deriving the most appropriate mathematical model for characterizing the membrane nanofiltration process and the detailed characterization of the efficiency of the membranes used
- determination of the biological activity of the obtained concentrated solutions of biologically active substances, including antibacterial and antioxidant activities

- detailed characterization of the composition of the obtained concentrated solutions of biologically active substances using modern chromatographic techniques (HPLC and GC)  
 - the effectiveness of spray drying of an extract from waste plant mass was studied in relation to the determined antioxidant activity.

**9. Evaluation of the compliance of the dissertation summary with the dissertation:**

A) Full compliance	4 points	<b>X</b>
B) Compliance of the main parts	2 points	
C) Lack of compliance of the main parts	0 points	
		one of the answers given is marked with the sign "X"

The evaluation must be substantiated if answer C is marked.

The abstract of the dissertation reflects its main parts, namely: Introduction, Aim and objectives, Materials and methods, Results and discussion, Summary, Conclusions and Contributions, which fully meets the requirements of the Act for development of the academic staff of the Republic of Bulgaria and presents in its entirety what has been achieved in the development of the dissertation.

**10. Participation of the doctoral student in the achievement of the results of the dissertation:**

A) The doctoral student has at least an equal participation	8 points	<b>X</b>
B) The doctoral student has secondary participation	5 points	
C) The participation of the doctoral student is unnoticeable	0 points	
		one of the answers given is marked with the sign "X"

Critical notes must be provided if one of the items B or C is marked.

I have known PhD student Yoana Stoyanova since she joined the Department of Biotechnology as a PhD student and I have had the pleasure of working with her, participating in discussions about her achieved results, both in the current dissertation and beyond it in our joint developments. In addition to her place in the publications presented on the dissertation, I have had the opportunity to personally see her undoubtedly positive qualities, desire to work and develop, both in the topic of the dissertation being developed, and in close and similar topics related to the study of biologically active substances and their activity. The doctoral student presents participation in a large number of scientific conferences to present the results of her work **24**, as well as participation in an enviable number of scientific projects **8**, specializations and trainings on the topic of the dissertation **5**. Yoana Stoyanova speaks English, German and Spanish and has, in my opinion, a number of other advantages, some of which are innovative ideas, a strong interest in biotechnology, analytical thinking and skills for effective problem solving, a strong interest in continuous improvement and lifelong learning and the ability to work in a team. All this has undoubtedly helped her to develop as a promising young scientist, to scientifically summarize and present to an international audience the results she obtained and gives me the conviction to claim that she was deeply and strongly integrated into the overall development of the dissertation work she presented, having fully fulfilled the requirements of the Act for development of the academic staff of the Republic of Bulgaria for acquiring the Ph. D. degree in the claimed professional direction 5.11. Biotechnology. In addition, she has acquired additional knowledge, skills and competencies as a result of the development of this dissertation, which have established her as a young and promising scientist in the field of the professional direction.

**11. Critical notes:**

A) Lack of critical notes	8 points	
B) Critical notes of a technical nature	7 points	<b>X</b>
C) Critical notes that would partially improve the results achieved	4 points	
D) Significant critical notes	0 points	
		one of the answers given is marked with the sign "X"

<p>Critical notes must be provided if one of the answers C or D is marked.</p> <p>It is absolutely possible that the number of contemporary publications on which the present dissertation is based is significantly greater than those discussed above by me, but it should be noted that about 1/3 of the publications are cited without indicating the year of publication, which greatly complicates their classification (see publications 11-13, 17, 29, 33, 40, 54-56, 62, 65, 69, 81, 82, 85, etc.). In addition, I will note that the manner of citing literature in the dissertation is heterogeneous.</p>
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## 12. Conclusion

A) The evaluation of the dissertation is <b>POSITIVE</b>	This evaluation is assigned to a total number of at least 65 points	<b>X</b>
B) The evaluation of the dissertation is <b>NEGATIVE</b>	This evaluation is assigned to a total number below 65 points	
		one of the answers given is marked with the sign "X"

<p>To be filled in at the request of the reviewer</p> <p>Based on the presented dissertation work and the achievements in it, as well as my personal contacts and impressions of the doctoral student Yoana Stoyanova, I confidently vote <b>positively</b> of awarding her the Ph.D. degree in the field of higher education 5. Technical Sciences, Professional direction 5.11. Biotechnology, in the scientific specialty Technology of Biologically Active Substances.</p>
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	The review was written by:	
date		signature