

REVIEW

regarding the competition for the academic position of "Associate Professor" in the field of higher education 5. Technical Sciences, professional field 5.11 Biotechnology (specialty: Biotechnology) for the needs of the "Bioremediation and Biofuels" Laboratory, Department of Biotechnology, Institute of Microbiology "Stefan Angelov" at the Bulgarian Academy of Sciences

Reviewer: Prof. Velislava Norova Lyubenova, PhD, Institute of Robotics, Bulgarian Academy of Sciences

1. Brief biographical information

By Order No. I-66/29.04.2025 of the Director of the Institute of Microbiology "Stefan Angelov" (IMicB) at the Bulgarian Academy of Sciences (BAS), I have been included in the Scientific Jury for the above-competition abovementioned competition, announced in the State Gazette, No. 21 of 14.03.2025. The only candidate is Chief Assistant Dr. Elena Yordanova Chorukova from the Laboratory "Bioremediation and Biofuels", Department of Biotechnology, IMicB-BAS.

Dr. Chorukova is a biotechnical engineer, having received her master's degree in 1994 from the Technical University of Sofia. She obtained her PhD degree at IMicB-BAS in 2009 in the scientific field 02.21.12 "Bioautomation" with the topic of her dissertation "Neural and hybrid modeling and optimization of biotechnological processes."

The scientific and research activity of Ch. Assis. Chorukova has been conducted almost entirely at IMicB-BAS, where she has worked successively as an engineer, research associate III, II, and I degrees, and since 2011 she has been a Chief Assistant. Her professional research interests are in the areas of modeling, optimization, and control of biotechnological processes, neural networks, metaheuristic algorithms, state observers (software sensors), computer systems, anaerobic degradation of organic waste, and bioreactors.

2. General description of the materials submitted

The provided copies of the competition documents contain:

- ✓ autobiography on the European model;
- ✓ copy of a diploma for the educational and scientific degree "Doctor";
- ✓ abstract of the dissertation for the acquisition of the scientific degree "Doctor";
- ✓ certificate of internship in the specialty;
- ✓ list of summaries of scientific publications for participation in the competition – in Bulgarian and English;
- ✓ list of citations of scientific publications;
- ✓ list of participation in scientific research projects;
- ✓ list of participation in national and international scientific forums;
- ✓ brief information about the research work, the main contributions in the given field, and views on future research work;
- ✓ reference for original scientific contributions;
- ✓ reference for fulfillment of the minimum requirements according to the Law on the Development of Academic Staff in the Republic of Bulgaria (LDASRB);
- ✓ reference for fulfillment of the additional requirements according to the IMicB-BAS;
- ✓ general list of publications;
- ✓ list of citations proving personal h-factor;
- ✓ copies of scientific publications for compliance with the minimum requirements under the ZRASRB and the additional requirements of the IMicB-BAS;

- ✓ declaration of originality and authenticity of the results presented in the scientific works, etc.

Regarding to the necessary documents for participation in the competition and their content, according to the regulatory framework of LDASRB, the Regulations for its implementation, the Regulations on the conditions and procedure for acquiring scientific degrees and occupying academic positions at the Bulgarian Academy of Sciences, and the Regulations on the conditions for acquiring scientific degrees and for holding academic positions at IMicB-BAS, I have no objections.

3. Fulfillment of minimum requirements

Dr. Chorukova meets and exceeds the minimum national requirements for the academic position of "Associate Professor" as defined by the LDASRB and BAS, as well as the additional requirements of the Institute of Microbiology at BAS for the academic position of "Associate Professor" (Table 1). The additional requirements are related to **20** publications after obtaining the academic degree of "Doctor," with the candidate having to be the first author in at least **5** of them. Dr. Chorukova significantly exceeds this requirement, presenting **33** publications for the competition, in **12** of which she is the first author. The second additional requirement is the presence of **100** citations for the entire career. The candidate has submitted **122** citations (excluding self-citations), **92** of which are in WoS, Scopus. The additional requirement for **3** projects has been met, as a list of Dr. Chorukova's participation in **14** projects has been submitted. The total impact factor of the publications for the candidate's entire scientific career is **30.684**, with a minimum requirement of **20**. She has also fulfilled the H-factor requirement for her entire scientific career.

Table 1

Group	Content	Min points LDASRB	Min points ImicB-BAN	Evidence material	Points and indicators of Dr. Chorukova
A	Indicator 1	50	50	Abstract of PhD Thesis	50
B	Indicator 4 Habilitation thesis – scientific publications that are referenced and indexed in world-renowned databases	100	100	Equivalent to a monograph, thematically united and systematized scientific works - publications (Reference for minimum requirements)	140.57
Г	Sum of indicators 5 to 11	200	20 publications (after "PhD") in 5 of them 1st author or corresponding (Reference for min. additional requirements to IMicB-BAS)	Reference for fulfillment of the additional requirements of IMik-BAS	257.51 33 publications in 12 of them first author
Д	Sum of indicators 12 to 15	50	100 citations (Reference for min. additional requirements to IMicB-BAS)	List of citations Reference for fulfillment of the additional requirements of IMik-BAS	1001 122 citations (excluding self-citations), 92 in WoS, Scopus

E	Sum of indicators 16 till the end	-	3 projects (Reference for min. additional requirements to IMicB-BAS)	List of projects Reference for fulfillment of the additional requirements of IMik- BAS	14 projects
	IF for the entire scientific career	-	20 (Reference for min. additional requirements to IMicB-BAS)	Reference for fulfillment of the additional requirements of IMik- BAS	30.82
	H-factor for the entire scientific career	-	5 (Reference for min. additional requirements to IMicB-BAS)	Reference for fulfillment of the additional requirements of IMik- BAS	5

4. General characteristics of the candidate's scientific and applied scientific activities

Ch. Assis. Dr. Chorukova has submitted 33 scientific publications for her participation in the competition. The publications cover the period 2015-2024. All of them are after the defense of a dissertation for the scientific degree "Doctor" with the exception of one publication from 2004, which is not included in the list of publications related to her dissertation work.

Ten of the publications referenced and indexed in world-renowned databases are presented as equivalent to a monographic work. Of the remaining 23 publications, group Γ7 includes 12 works referenced and indexed in the world evaluation system (WoS or Scopus). Group Γ8 includes the remaining 11 publications. In 12 publications, the candidate is the first author ([B4.1, B4.5, B4.7, B4.9], [Γ7.11, Γ7.13- Γ7.15, Γ7.17, Γ7.19] and [Γ8.27, Γ8.33]) (from the reference for fulfilling the minimum requirements).

The publications submitted for the competition have a high overall impact factor, as most of them have been published in prestigious journals with an impact factor (IF) and impact rank (IR). There are 12 publications with an IF, and 8 with an IR. The high quality of the publications can also be judged by the quartiles of the editions in which they were published: with Q1 there are 2 (numbers 10,15 from the list of publications), with Q2 there are 6 (1,2,4,5,12,16), with Q3 there are 5 (3,7,8,17,20) and with Q4 there are 7 (6,9,11,13,14,18,19).

The candidate participated in the development of a protected patent "Biofilm reactor with submerged stationary full for biogas production".

She has presented a list of 48 of her presentations in national and international scientific forums, of which 22 were reports, 26 were posters and 28 have been presented at international scientific forums.

Dr. Chorukova has participated or been the manager of 14 projects, of which 11 are national and 3 are funded by the European Union. She has participated in 3 individual grants that are external to the IMicB-BAS. Of the national ones, 9 are funded by the National Science Foundation and 1 by the National Innovation Fund. Dr. Chorukova has been the manager of two of the projects funded by the National Science Foundation, one of which is ongoing.

The topics of these contracts are naturally and logically related to Dr. Chorukova's scientific interests, as well as to the results in the publications submitted for the competition, which are in the field of biotechnology and bioengineering. The main research areas are the anaerobic digestion processes of various types of organic waste (lignocellulosic waste, corn waste product, as well as mixtures of various wastes). The candidate's research work is primarily focused on mathematical modeling, control and optimization of the aforementioned biotechnological processes, with a focus on the application of various deterministic and artificial intelligence

methods for mathematical modeling. The candidate participated in the development of a biofilm reactor, a pilot biogas plant with a monitoring and control system, a control system for a cascade of bioreactors for the production of hydrogen and methane from organic waste, as well as in conducting experimental studies of the processes in the above-mentioned plant and system, and analysis of the results. Of the 10 publications presented in the reference for fulfilling the minimum requirements of the LDASRB as equivalent to a monographic work, one (B4.3) is related to a comparative analysis of process models carried out in a cascade of two bioreactors and in a single bioreactor, 2 of them (B4.9 and B4.10) – with the application of artificial intelligence methods for mathematical modeling, management and optimization of a biotechnological process, 7 – with the implementation and research of biotechnological processes for anaerobic degradation of various substrates:

(B4.1) – with corn extract;

(B4.2) - metagenomic analysis of the process with corn waste product;

(B4.4, B4.5, B4.6) – with lignocellulosic substrates, mainly wheat straw.

Publications B4.8 and B4.9 are related to studies conducted with the biofilm reactor.

5. Scientific and applied scientific contributions

Ch. Assis. Dr. Chorukova has submitted a reference including 12 original scientific contributions. Those related to her dissertation cannot be recognized according to the Regulations on the Terms and Procedure for Acquiring Scientific Degrees and Holding Academic Positions at the Bulgarian Academy of Sciences (Art. 4.5), which states that the Scientific Jury assesses the originality of the **submitted** works.

Scientific and applied scientific contributions could be systematized in three directions as follows:

I. Development of a biofilm reactor, installation and systems for monitoring and control of anaerobic digestion processes based on different types of raw materials. Conducting experimental studies and analyzing the results

- 1.1 A biofilm reactor with a submerged fixed bed has been designed for biogas production, in which suitable conditions for fixation of microorganisms on the solid support have been created [7, 8].
- 1.2 A pilot biogas plant with a monitoring and control system has been developed. It is designed for the implementation and scaling up of various anaerobic digestion technologies based on different types of feedstock. Numerous experimental studies demonstrate the good performance of this plant and its potential for industrial applications. [30]
- 1.3 A control system for a cascade of bioreactors for the production of hydrogen and methane from organic waste has been developed. The system has been implemented with the aim of verification and scaling up of various technologies for two-phase anaerobic biodegradation of various organic wastes.[28]
- 1.4 Experimental studies have been conducted and a computer system for monitoring and controlling two-phase anaerobic digestion of corn waste in automatic and semi-automatic operating modes of a cascade of two anaerobic bioreactors has been presented. With the help of the developed computer system for monitoring and controlling pilot bioreactors, an automatic operating mode in a continuous process with simultaneous production of hydrogen and methane has been implemented. [21], [27].

II. Mathematical modeling, analysis, control and optimization of biotechnological processes

Based on the research conducted in laboratory and pilot plants and analysis of experimental data, the following have been developed and implemented:

- 2.1 A deterministic mathematical model of the anaerobic digestion of waste fruits and vegetables for methane production, including the gas phase. The model has been verified experimentally and through computer simulations [19]
- 2.2 Deterministic models of a continuous anaerobic digestion process with hydrogen and methane production in a cascade of two bioreactors [15] of the following substrates: lignocellulosic waste [4, 5, 32], corn waste product [1], as well as mixtures of different wastes. Based on the models, the optimal ratio of the working volumes of the bioreactors was determined to maximize energy production [17].
- 2.3 Schemes for estimating the specific growth rates of the participating bacteria for some of the models [18] and a robust extremum search algorithm for controlling a two-stage process while maximizing gas yields [20]
- 2.4 Metagenomic analysis of the corn waste product process [2]
- 2.5 A review of literature sources related to recent advances in the field of two-stage anaerobic digestion for green energy production. [12]

III. Application of artificial intelligence methods for mathematical modeling, control and optimization of biotechnological processes

- 3.1 A mathematical model of the thermophilic anaerobic digestion process of wheat straw, carried out in a bioreactor for methane production, has been developed based on parametric identification performed using a metaheuristic genetic algorithm. [5]
- 3.2 A high-quality nonlinear mathematical model of the two-stage decomposition process of corn waste for the sequential production of hydrogen and methane has been developed based on parametric identification performed through adapted and implemented for the first time four metaheuristics: genetic algorithm, Firefly algorithm, Cuckoo search algorithm, and Coyote optimization algorithm. [16]. A metaheuristic Crow Search Algorithm has been successfully applied to model this process. [10]

As scientific contributions, I would include the one related to the patent for the biofilm reactor 1.1, as well as the developed mathematical models – 2.2, 3.1 and 3.2 and the overview 2.5.

5. Critical remarks and recommendations

There is no systematic presentation of the publications equivalent to a monographic work. This does not affect my opinion of the research and results presented in the publications. I highly appreciate their contribution and emphasis on topics important to society and the economy. My recommendation is that Dr. Chorukova summarizes her results in a monograph, which would be extremely useful for the work of future researchers in the field.

6. Significance of contributions to science and practice

The candidate's contributions are significant for science and practice, as Ch. Assistant Dr. Chorukova works on current and socially significant topics related to the production of green energy. The proposed innovative approaches, methods and models have been successfully tested based on data from numerous experiments conducted in the developed pilot biogas plant and a control system for a cascade of bioreactors. They are a basis for verification and scaling of various technologies for single-phase and two-phase anaerobic digestion of various organic wastes, which is a prerequisite for their implementation in practice. The development of the accepted patent for a biofilm bioreactor is an innovation that is significant and has the prospect of successful implementation.

From all that has been said, it follows that Dr. Chorukova's developments enrich science and practice in the areas in which the candidate works and increase the effectiveness of the objects to which they are applied.

6. Personal impressions

I have known Dr. Chorukova for many years, mostly from our participation in various scientific events, as we work on similar topics. My impressions of her are excellent. She is an ambitious, established scientist and a recognized expert nationally and internationally in the field she works. She is communicative and works very well in a team.

CONCLUSION

The candidate for the announced competition, Chief Assistant Dr. **Elena Yordanova Chorukova**, fully satisfies the conditions, criteria and requirements for the election to the academic position of "Associate Professor" according to the Law on the Development of the Academic Staff of the Republic of Bulgaria, the Regulations for the Implementation of the Law on the Development of the Academic Staff of the Republic of Bulgaria, The Regulations on the conditions and procedure for acquiring scientific degrees and occupying academic positions at the Bulgarian Academy of Sciences and the Regulations on the specific conditions for acquiring scientific degrees and occupying academic positions at the Institute of Microbiology-BAS. Considering the above and the overall scientific and applied scientific activity of the candidate, I give my positive vote and convinced recommend to the esteemed members of the Scientific Jury to vote positively for the selection of the candidate, as well as to propose to the Scientific Council at the Institute of Microbiology "Stefan Angelov" at the Bulgarian Academy of Sciences, **to choice Chief Assistant Dr. Elena Yordanova Chorukova** for the **academic position of "Associate Professor"** in the field of higher education 5. Technical Sciences, professional field 5.11 Biotechnology (specialty: Biotechnology) for the needs of the "Bioremediation and Biofuels" Laboratory, Department of Biotechnology.

12.06.2025 .

Sofia

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