

# OPINION

by professor Petko Nedyalkov Denev, PhD

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on a PhD thesis for acquisition of educational and scientific degree “Doctor in philosophy” (PhD);  
in the field of higher education **4. Natural sciences, mathematics and informatics;**  
professional field **4.2. Chemical sciences;**  
doctoral program **Organic chemistry**

**Author:** Maria Valentinova Bachvarova

**Title:** Synthetic transformations of 2-aryl thiazole and benzothiazole compounds

**Supervisor:** assoc. prof. Stela Statkova-Abeghe, PhD

## 1. General presentation of the procedure and the PhD candidate

By Order No. RD-22-1002 dated 15.05.2026 of the Rector of the Paisii Hilendarski University of Plovdiv, I was appointed as a member of the scientific jury for the procedure for the defense of a PhD dissertation entitled “Synthetic Transformations of 2-Aryl Thiazole and Benzothiazole Compounds” for the acquisition of the educational and scientific degree “Doctor” in the field of higher education 4. Natural Sciences, Mathematics and Informatics, professional field 4.2. Chemical Sciences, PhD program “Organic Chemistry”. The author of the dissertation is Maria Valentinova Bachvarova, a full-time PhD student at the Department of Organic Chemistry under the supervision of Assoc. Prof. Stella Statkova-Abeghe, PhD.

The submitted set of documents complies with the requirements of Article 36 (1) of the Regulations for the Development of the Academic Staff of the University of Plovdiv and includes all required materials: curriculum vitae, dissertation thesis, abstracts in Bulgarian and English, a list and copies of the scientific publications related to the dissertation topic, a declaration of originality and authenticity of the submitted documents, as well as a report on compliance with the minimum national requirements under the Regulations for the Implementation of the Academic Staff Development Act.

The PhD candidate has submitted two scientific publications related to the dissertation topic, which are peer-reviewed and are considered sufficient for the purposes of the present procedure.

## 2. Relevance of the topic

The relevance of the studied problem is determined by the growing interest in the development of new biologically active heterocyclic compounds with potential applications in medicine and the

pharmaceutical industry, particularly as antitumor agents. Thiazole and benzothiazole derivatives represent an important class of compounds exhibiting diverse biological activities, including antitumor, antimicrobial, and antioxidant effects. In recent years, special attention has been paid to hybrid molecules combining different pharmacophoric fragments in order to achieve enhanced efficiency and multifunctional activity. Despite the significant progress in this field, there is still a need for the development of new synthetic approaches for obtaining structurally diverse thiazole and benzothiazole derivatives, as well as for investigating the relationship between their structure and biological activity. This determines the high scientific and practical significance of studies focused on the synthesis and functionalization of new heterocyclic systems with potential application as biologically active molecules.

### **3. Knowledge on the topic**

The PhD candidate has reviewed, analyzed and cited a total of 264 scientific publications related to the dissertation topic, which provides a solid basis for the comprehensive presentation of the current state of the problem and the achievements in this research field. The literature review is logically structured and presents the contemporary state of research on 2-substituted thiazole and benzothiazole compounds, with emphasis placed on their biological activity, synthetic methods, and possibilities for subsequent chemical transformations. Particular attention is paid to phytoalexins as naturally occurring biologically active molecules, as well as to the antitumor properties of camalexin and its structural analogs. Ferrocene-containing hybrid molecules and multifunctional hybrids with potential combined biological activity and application as antitumor agents are also thoroughly analyzed. A significant part of the review is devoted to synthetic approaches for obtaining 2-aryl and 2-heteroaryl thiazole and benzothiazole derivatives. Methods for the synthesis of methoxycamalexins, benzocamalexins, and ferrocene-containing structures are presented, together with various condensation reactions for the construction of the benzothiazole core. Modern strategies for C-arylation and  $\alpha$ -amidoalkylation reactions are also discussed as effective approaches for the functionalization of thiazole and benzothiazole systems. The final section of the literature review analyzes oxidative transformations of heterocyclic compounds and formylation reactions, including methods for introducing a “hidden” formyl group, which represent important tools for the further modification and synthesis of new biologically active heterocyclic molecules. It also makes a very good impression that the aim of the dissertation is clearly defined, while the objectives are well formulated and specific.

#### **4. Evaluation of the methodology of the study**

The methods applied in the dissertation are very well selected in order to achieve the stated aim and objectives. Various approaches for the synthesis, isolation and purification of the studied compounds have been employed. Reliable spectral methods, including NMR and IR spectroscopy, among others, were used for structural elucidation. The acquisition and application of such a wide range of methods by the PhD candidate undoubtedly contributed to the educational value and scientific quality of the dissertation.

#### **5. Evaluation of contributions and significance of development for science and practice**

The main contributions of the dissertation are related to the development of new synthetic approaches for obtaining thiazole, benzothiazole, and imidazoline derivatives with potential biological activity. For the first time,  $\alpha$ -amidoalkylation reactions of ferrocene, indole, and phenolic derivatives with various N-acyliminium reagents were carried out, resulting in the synthesis of a series of new hybrid molecules and camalexin analogs. Efficient conditions for oxidative aromatization and for the synthesis of the natural compound N-methylcamalexin in gram-scale quantities were also developed. Another significant contribution is the development of an approach for the synthesis of differently substituted indole-3-carbaldehydes and aromatic aldehydes through reductive transformations and unveiling of a “hidden” formyl group. As a result of the conducted research, a total of 43 compounds were synthesized, 28 of which are new and previously undescribed in the literature, and all were structurally confirmed by modern spectral methods.

#### **6. Evaluation of the scientific publications from the dissertation**

The PhD candidate has presented two scientific publications in specialized journals with impact factor (*Journal of Organometallic Chemistry*, IF 2023 – 2.1, Q2 and *Molecules*, IF 2024 – 4.6, Q1). Considering the scientometric indicators of the journals, these publications provide 20 and 25 points, respectively, under group “I” indicators of the Regulations for the Implementation of the Academic Staff Development Act. Thus, the PhD candidate has accumulated a total of 45 points, exceeding by 50% the required minimum of 30 points. It also makes a very good impression that the results of the dissertation work have been actively disseminated through thirteen oral and poster presentations.

#### **7. Evaluation of the extended abstract of the doctoral thesis**

The abstract is structured in a similar way to the dissertation and reflects well the aim, tasks, methods and materials, the main results of the work.

## **8. Critical remarks and recommendations**

I have no critical comments or remarks regarding the obtained results, their interpretation, or the formulated conclusions.

## **CONCLUSION**

The dissertation thesis entitled “Synthetic transformations of 2-aryl thiazole and benzothiazole compounds” authored by Maria Bachvarova contains scientific and scientific-applied results that represent an original contribution to science and, in terms of both quality and scope, exceed the requirements of the Academic Staff Development Act in the Republic of Bulgaria, the Regulations for its implementation, and the respective Regulations of the Plovdiv University „Paisii Hilendarski“. The dissertation demonstrates that the PhD candidate possesses profound theoretical knowledge and professional skills in the field of Organic Chemistry, while also showing the ability and competence to independently conduct scientific research.

Based on the above, I confidently give my positive evaluation of the conducted research presented in the reviewed dissertation thesis, abstract, obtained results, and contributions, and I recommend that the honorable scientific jury award the educational and scientific degree “Doctor” to Maria Bachvarova in the field of higher education 4. Natural Sciences, Mathematics and Informatics, professional field 4.2. Chemical Sciences, PhD program “Organic Chemistry”.

15.06.2026

Opinion made by: .....

Prof. Petko Denev, PhD