REVIEW
by
Professor Eng. Vladimir B. Bojinov, DSc
Corresponding member of Bulgarian Academy of Sciences
University of Chemical Technology and Metallurgy, Sofia, Bulgaria

Member of the Academic Jury set to render a decision
on a procedure for the acquisition of Academic Degree

"Doctor of Science" (DSc)

in the Professional Field 4.2. Chemical Sciences
according to the Classifier of the Areas of Higher Education and the Professional Fields
(Scientific Specialty "Organic Chemistry")

Dissertation:
NEW COMPOUNDS AS PERSPECTIVE ANTITUBERCULAR AND ANTIVIRAL AGENTS

Authored by
Assoc. Prof. Georgi Milchev Dobrikov, PhD
Institute of Organic Chemistry with Centre of Phytochemistry,
Bulgarian Academy of Sciences (IOCCP-BAS)

1. Subject to review

The set of materials presented by Assoc. Prof. Georgi Milchev Dobrikov is in accordance with the Regulations for the Development of the Academic Staff of IOCCP-BAS, and meets the criteria of IOCCP-BAS for the acquisition of the scientific degree "Doctor of Sciences".

Assoc. Prof. Georgi Dobrikov has attached a dissertation (in English) and an abstract (in Bulgarian and English), as well as copies of 8 publications on the subject of the dissertation and 25 summaries of participation in scientific forums.

In addition to the required lists of publications and conference attendance, he has also submitted a list of 8 research projects related to the dissertation, 4 of which have been implemented under his supervision.

Of the 8 scientific papers presented, all in journals with a high impact factor, 4 are publications in journals with rank **Q1** (100 points), and the remaining 4 publications are in journals with rank **Q2** (80 points). The total number of points under indicator D is 180 points, which exceeds the minimum threshold of 150 points.

A list of 303 citations of Assoc. Prof. Dobrikov's scientific works is also presented, which do not repeat those presented in the procedure for the acquisition of the educational and scientific degree "Doctor". The total number of points for this indicator (E) is 606, which significantly exceeds the minimum of 200 points required by the Regulations of the IOCCP-BAS.

2. Brief biographical information about the candidate

Georgi Milchev Dobrikov was born on April 28, 1974 in the town of Smolyan, Bulgaria. He completed his secondary education in 1993 at the Technical College of Construction, Geodesy and Cartography - Smolyan. He completed his higher education with honors in 1998 at the Faculty of Chemistry of the Sofia University "St. Kliment Ohridski" majoring in "Organic and Analytical Chemistry". During the period 1998-1999, he worked at the Institute of Polymers at the Bulgarian Academy of Sciences, and from 1999 to 2001 at the National Center for Public Health Protection. From October 2001 to 2004, he was a full-time doctoral student at the Institute of Organic Chemistry with the Centre of Phytochemistry at the Bulgarian Academy of Sciences in the

scientific specialty “Organic Chemistry” under supervision of Prof. Vladimir Dimitrov. From 2004 to 2006, he was an assistant of the professor in the “Organic Synthesis and Stereochemistry” Laboratory of the Institute of Organic Chemistry with Centre of Phytochemistry at the Bulgarian Academy of Sciences. In 2006, he received the educational and scientific degree “doctor” after successfully defending his thesis “Obtaining chiral ferrocene derivatives - absolute configuration and application in asymmetric synthesis”. From 2007 to 2016, he worked as a chief assistant of the professor, and from 2016 to now he is an associated professor in the Laboratory “Organic Synthesis and Stereochemistry” of the Institute of Organic Chemistry with Centre of Phytochemistry at the Bulgarian Academy of Sciences.

3. Actuality of the topic and expediency of the set goals and tasks

The dissertation is presented on 175 pages, includes 34 figures, 28 tables and 29 schemes. More than three hundred literary sources were used.

The aim of the dissertation is the synthesis of new compounds as *in vitro*/*in vivo* antitubercular and antiviral agents with low cytotoxicity and improved pharmacological properties.

The main emphasis of the dissertation is placed on the design and synthesis of a wide range of new 2-aminobutanol derivatives (*N*-acyl, *N*-alkyl/aryl, heterocyclic, ureas, thioureas and acylthioureas), (-)-fenchone (amides, cinnamamides) and (+)-camphor (amino- and amidoalcohols), as well as a series of the diaryl ether analogues of (2-(3,4-dichlorophenoxy)- 5-nitrobenzonitrile (MDL-860). Despite intensive worldwide work and the large number of anti-tubercular and antiviral drugs created, the observed drug resistance and the insufficient achievements in antiviral chemotherapy are a serious challenge to the scientific community to search for new, more effective medicines, including through the principle of random screening. Therefore, the research of Assoc. Prof. Dobrikov can be defined as up-to-date and innovative with a fundamental and scientific-applied character.

4. Knowledge of the problem

The literature review is presented concisely and informatively and corresponds directly to the stated objective, focusing mainly on the damage that tuberculosis and viral infections have caused and continue to cause to humanity, as well as on the history and present of the antitubercular and antiviral chemotherapy.

The characteristics that anti-tuberculosis drugs should possess, their variety, the current trends in their development, and the WHO guidelines for their use in treatment regimens are analytically discussed. Current trends in TB drug development are also discussed and the importance of random screening as an effective research approach is justified.

The problems related to the low effectiveness of antivirals as well as the reasons for their low in vivo activity, are thoroughly discussed. The main classes of chemical compounds on the basis of which antivirals have been developed (WIN-compounds, pyridazines, isoxazoles, imidazolidinones, alkyl-aryl ethers, chalcones and flavonoids, guanidines and benzimidazoles, diaryl ethers) are presented in all their diversity, with the emphasis being placed on diaryl ether analogues and the variety of methods for their preparation.

The literature review unequivocally demonstrates the high competence of Associated Professor Dobrikov in the field of antibacterial and antiviral chemotherapy, which are the starting point of his scientific research.

5. Research methodology

The chosen research methodology in the Assoc. Dobrikov's dissertation is based on the design and synthesis of a wide range of new pharmacophore molecules and their testing for anti-tuberculosis and antiviral activity through random screening technology and, where possible, with the support of QSAR analysis.

The chosen research methodology should be perceived as appropriate, which is evidenced by the encouraging results obtained in fulfilling the set goal and solving the tasks formulated in the dissertation.

6. Characterization and evaluation of the dissertation and its scientific contributions

The results achieved in the dissertation related to the efforts to synthesize a large number of new compounds with diverse structural origin and the study of their antibacterial and antiviral activity are clearly presented and critically commented. A total of 296 new compounds were synthesized, 159 of which with expected antitubercular activity and 137 with expected antiviral activity. The synthesized compounds are fully characterized and proven with the best methods of structural analysis, incl. mass spectrometry, NMR spectroscopy in all its varieties, X-ray structural and elemental analysis.

In accordance with the scientific profile of Assoc. Prof. Dobrikov, the emphasis of his dissertation is on the synthesis and characterization of new compounds of various classes with supposed antitubercular/antibacterial and antiviral activity. To realize the set goal, the research was conducted in two main directions - development of new compounds with anti-tuberculosis and antiviral activity. The scientific achievements in the dissertation work and its scientific contributions can be grouped into two main directions:

1) Development of new compounds with potent in vitro antitubercular and antibacterial activity

1.1. Fifty new *N*-acylated, *N*-alkylated, and *N*-arylated derivatives of commercially pure (*R*)-2-amino-1-butanol, as well as 22 new ureas, thioureas, and acylthioureas, bearing (*R*)-2-amino -1-butanol fragment, which can be considered as a new subclass of analogs of the classic antitubercular drug ethambutol, were synthesized and their antimycobacterial, antibacterial, and antifungal activities was investigated.

- N-acylated derivatives were obtained by acylation with acid chlorides, esters, aldehydes and anhydrides of aliphatic and aromatic dicarboxylic acids under standard conditions or by improved synthetic strategies in the presence or absence of solvent. Several new heterocyclic amide derivatives of 2-amino-1-butanol have also been synthesized by its condensation with homophthalic and anthranilic acids or (+)-camphor.
- The mono- and di-*N*-alkylated and *N*-arylated derivatives of the 2-amino-1-butanol were prepared by a standard procedure upon its reaction with alkyl- and aryl halides in the presence or absence of a solvent, while the series of substituted benzyl-type amino alcohols was synthesized by reductive amination of aldehydes.
- The urea derivatives containing an (*R*)-2-amino-1-butanol fragment were obtained in high yields and purity by reactions of 2-amino-1-butanol with mono- and bis-isocyanates in a dry organic solvent medium, at reaction with urea in anhydrous media or by standard acylation.
- The thioureas containing an (*R*)-2-amino-1-butanol fragment were obtained in high yields in a similar manner, but by reaction with isothiocyanates.
- The acetylthioureas were obtained in moderate yields by a known procedure involving reaction of acyl halides with ammonium thiocyanate in the presence of polyethylene glycol 400 and further reaction with 2-amino-1-butanol.
- The in vitro antitubercular activity of the synthesized *N*-acylated, *N*-alkylated and *N*-arylated derivatives showed excellent activity with low cytotoxicity for 4 of the compounds, while the in vitro antibacterial activity tests of most of the compounds against 13 pathogenic bacteria and fungi showed broad antibiotic activity for 3 compounds of this series.
- Studies on in vitro antitubercular activity of synthesized ureas, thioureas and acylthioureas have shown that one of the compounds demonstrates high activity with low cytotoxicity.

The main scientific contribution that can be derived from the development of this group of compounds consists in the creation of a new subclass of analogs of the classic antitubercular drug

ethambutol. Some of these derivatives exhibited significantly higher activity than ethambutol at lower cytotoxicity.

1.2. Fifty new diastereomerically pure bicyclic compounds with a fenchane skeletons, containing an *N*-substituted γ-aminoalcohol with expected improved antitubercular activity as a result of the presence of the lipophilic (-)-fenchone in their structures were synthesized. 17 enantiopure amides and 33 derivatives of cinnamic acid containing fused, substituted aryl and heteroaryl moieties were obtained. The starting point for all syntheses is an enantiometrically pure aminoalcohol with a fenchane skeleton, which was synthesized as a part of the PhD dissertation of Assoc. Prof. Dobrikov.

- Some of the *N*-acylated derivatives (12) were obtained in high yields after acylation of the starting amino alcohol with a fenchane skeleton with commercial acid chlorides under standard conditions in dry methylene chloride or by simple aminolysis of the amino alcohol with esters of structurally different carboxylic acids in the absence of solvent.
- Three amido alcohols were synthesized by an amide coupling reaction between the starting amino alcohol and various aromatic or heterocyclic carboxylic acids in the presence of an activating peptide synthesis agent. Two more derivatives of the starting fenchane amino alcohol were synthesized by reactions with commercial ethyl isocyanate and 1,3-bis(benzyloxycarbonyl)-2-methyl-isothiourea.
- The cinnamic acid derivatives containing the fenchane fragment (33) were obtained by standard acylation of the starting amino alcohol with halogen-containing cinnamoyl chlorides or by peptide synthesis with differently substituted cinnamic acids and its analogs in the presence of an activating agent and a base.
- Studies on the in vitro antitubercular activity of the synthesized (-)-fenchone amides have shown that, in general, the compounds have a moderate level of antimycobacterial activity, which for most of them varies between 30 and 70% of that of ethambutol. The most active antimycobacterial agent of this series (cinnamic sulfonamide), due to its good selectivity, is of particular interest as a good candidate for an effective chemotherapeutic agent.
- Studies on the in vitro antitubercular activity of the synthesized cinnamamides with a fenchane skeleton have shown similar results – a moderate level of antimycobacterial activity between 30 and 70% of that of ethambutol. It is suggested that the modified fenchane skeleton is mainly responsible for the antimycobacterial activity, while the contribution of the cinnamoyl residues in this regard is minor. However, due to its high selectivity and low cytotoxicity, one of the compounds in this series is a promising structure for further optimization.

The main scientific contribution of the development of this group of compounds is the creation of a new class of synthetic antitubercular compounds with a fenchane skeleton possessing moderate antimycobacterial activity.

1.3. Thirty-five new derivatives of (+)-camphor with expected antibacterial/antitubercular activity, including pyrimidine and arylidene residues in their molecules, were synthesized. The structures of all compounds were designed after a thorough literature search. Twenty arylmethylidene ketones and 15 pyrimidines with camphane skeletons were obtained.

- Conjugated ketones were synthesized by reaction of enantiopure (+)-camphor with variously substituted aromatic, heterocyclic and ferrocene aldehydes in an inert medium in the presence of a base. Part of the necessary aldehydes, which are not commercial products, were synthesized using purposefully developed technologies.
- Aryl substituted 2-aminopyrimidines were synthesized in high yields by a significantly improved two-step synthetic methodology by condensation of the resulting arylidene ketones with excess of guanidine hydrochloride. The possibility of obtaining *N*-acyl derivatives of aryl-substituted 2-aminopyrimidines by acylation with acid chlorides was also demonstrated.

- All reactions have been shown to carry out without change in the configuration of the camphane skeleton. The preparation of enantiometrically pure products was further confirmed by X-ray structural analysis.
- The in vitro antitubercular activity studies of this series of compounds against 11 multidrug-resistant strains of *Mycobacterium tuberculosis* (*M. tb*) have shown that two arylmethylidene ketones with a camphane skeleton possess very good antitubercular activity and metabolic stability. It has also been established that 2-aminopyrimidine derivatives are completely inactive and are not suitable antitubercular agents.
- Tests for the in vitro antibacterial and antifungal activity of all compounds against 4 types of fungi and pathogenic bacteria have shown that one compound of the series (a 2-aminopyridine derivative with a trimethoxyaryl residue) demonstrates excellent characteristics as a broad-spectrum antibiotic active against all tested bacteria and fungi compared to the reference gentamicin. Other more than 10 compounds of the series possess high selective activity against specific bacterial species.

The main scientific contribution of the development of this group of compounds is the creation of a new class of synthetic antitubercular compounds with a camphane skeleton possessing high antitubercular and antimicrobial activity.

1.4. Small group of 6 new nitrofuranyl amides with expected antitubercular activity were synthesized by classical acylation of various primary or secondary amines containing aromatic, fenchone, nitroimidazole and arylpiperazine residues with 5-nitrofuran-2-carbonyl chloride in dry methylene chloride and in the presence of excess of triethylamine.

- The antitubercular activity of the synthesized nitrofuranyl amides and their possible mechanism of action/resistance were investigated by whole genome sequencing of spontaneous mutants of *Mycobacterium tuberculosis* (*M. tb*). Six mutations in 6 genes were identified. Three of the compounds demonstrated excellent antitubercular activity.

The main scientific contribution from the development of this group of compounds is the design and preparation of new nitrofuranoyl derivatives and the study of their possible mechanism of antitubercular activity using in vitro induced mutagenesis.

2) Development of new compounds with expected antiviral activity

A large group of 137 new compounds with expected antiviral activity, which can be broadly defined as analogs of the diaryl ether 2-(3,4-dichlorophenoxy)-5-nitrobenzonitrile (MDL-860), was synthesized:

2.1. Twelve new compounds bearing a 2-cyano-4-nitrophenyl unit, linked to various aromatic or aliphatic groups via O, N or S atom were synthesized.

- The target compounds were obtained in high yields by one-step synthesis where differently substituted phenols, thiophenols or amines reacted in the presence of base with 2-chloro-5-nitrobenzonitrile.
- The tests of the compounds for their in vitro cytotoxicity and antiviral activity against three enteroviruses - poliovirus 1 (PV1), coxsackieviruses B1 (CVB1) and B3 (CVB3) showed that 3 of the compounds were highly active against PV1 and CVB1, and 2 others were moderately active against CVB3 at low cytotoxicity for all tested compounds.
- The analysis of the conducted biological studies has shown that the 2-cyano-4-nitrophenoxy group is a basic building block for the existence of antiviral activity of this class of compounds. The active compounds contain two to three halogen atoms in the second aromatic ring, and a loss of efficiency was found when the bridging oxygen was replaced by another heteroatom (N, S), when the aryl moiety was replaced with different heterocycles, and when the halogens were replaced with other substituents in the second aromatic ring.

2.2. Another 61 new compounds bearing a 2-cyano-4-nitrophenyl moiety linked to various aromatic or aliphatic groups via an O, N or S atom were synthesized in search of improved antiviral activity.

- All compounds were prepared analogously to the first similar group of 12 compounds by simple one-step nucleophilic aromatic substitution of a series of phenols, alcohols, thiols, amines, and N-heterocycles with 2-chloro-5-nitrobenzonitrile in the presence of base.
- Similar antiviral activity tests performed on this series of MDL-860 analogs have shown that one of the compounds has a broad spectrum of activity (against PV1, CVB1 and CVB3). A few other compounds demonstrated specific activity against any of the indicated viruses, while the majority of compounds showed moderate or no activity at all. The obtained results unequivocally confirm the conclusions made in the first group of 12 compounds, about the relationship between the structure of this series of compounds and their antiviral activity.

2.3. Several series of a total 42 new compounds, analogs of the diaryl ether MDL-860 containing two aromatic moieties linked by different heteroatoms (O, N, S), were synthesized in order to screen their in vitro activity against a panel of different viruses and to develop appropriate QSAR models.

- By reaction of commercial 2-fluoro-5-nitrobenzonitrile with phenols and thiophenols, alcohols and secondary amines in the presence of a base, 22 different diaryl- or aryl-alkyl ethers, diarylthioether and aryl-heteroalkyl amines were obtained. Another 2 compounds were obtained after peripheral synthetic modification of previously synthesized diaryl ethers.
- New 5 diaryl ether-acids were obtained by reaction of 2-chloro-5-nitrobenzoic acid with various dihalogenophenols in the presence of a base. Three of the synthesized aromatic carboxylic acids were transformed into the corresponding amides after reactions with ethyl chloroformiate and ammonium chloride in a medium of tetrahydrofuran and triethylamine.
- A small series of 7 new diaryl ethers was obtained by reacting 3,4-dichloro- or 3,4-difluorophenols with halophenols containing two acceptor groups or a combination thereof (nitro, cyano, trifluoromethyl) in the second and fourth positions of the aromatic nucleus. One aryl-heteroaryl thioether was obtained by reaction of 2-chloro-5-nitrobenzonitrile with 2-mercaptobenzothiazole, and two other diaryl ethers were synthesized because of QSAR analysis, by interaction of 2-chloro-5-nitrobenzonitrile with hydroxybenzophenones. The synthesis of the latter two compounds was motivated as a possibility to consider them as analogues of drug for the treatment of abnormal blood lipid levels.
- Studies on the in vitro antiviral activity of this group of compounds against six viruses (PV1, CVB1, CVB3, human adenovirus, herpes simplex virus type 1 and human coronavirus) have shown that they are all inactive against PV1, CVB1 and CVB3, but 2 of the compounds were determined to be remarkably active, one against the coronavirus and the other against the adenovirus.
- The action mechanism of MDL-860 diaryl ether has been established. The main scientific contribution of the development of this group of compounds is the creation, also with the help of QSAR analysis, of a wide range of diverse analogues of the known antiviral agent MDL-860, as well as the study of the mechanism of its action. A significant number of structures have been identified as highly active and non-toxic in vitro, and some of the active compounds have shown good in vivo activity.

All the contributions of the dissertation work of Assoc. Prof. Dr. Georgi Dobrikov can be defined as scientific and scientifically applied and to be related to the demonstration with new instruments of essential new aspects of already existing scientific areas and problems.

7. Assessment of dissertation publications

Assoc. Prof. Dobrikov has included in his dissertation for obtaining the scientific degree "Doctor of Sciences" **8 scientific articles**, published between 2015 and 2022. There is no information about the use of these publications in other dissertations for obtaining the scientific degree "Doctor of Science". At the same time, due to the collective nature of Assoc. Prof. Dobrikov's publications and according to the rules of the Bulgarian Academy of Sciences, these scientific works will not be able to be used as part of other dissertations for the acquisition of the scientific degree "Doctor of Sciences".

It should be noted with pleasure that all scientific articles of Assoc. Prof. Dobrikov, included in the dissertation work, were published not just in journals with high impact factor, but in extremely prestigious international journals in the field, such as *Biomedicines* (IF = 4.757), *Pharmaceuticals* (IF = 5.215), *Antiviral Chemistry and Chemotherapy* (IF = 1.89), *Bioorganic & Medicinal Chemistry Letters* (IF = 2.454), *ACS Infectious Diseases* (IF = 4.325), *Bioorganic Chemistry* (IF = 4.831) and *ChemistrySelect* (2 issues, IF = 2.307). The total impact factor of these publications is 28.086 or an average of 3.51 per publication, which is a serious certificate for the quality of the scientific production of Assoc. Prof. Dobrikov. Four of the articles were published in Q1-ranked scientific journals, and the remaining four publications were in Q2-ranked journals.

A list of 26 participations in conferences on the subject of the dissertation at home and abroad with 6 oral and 20 poster reports is also presented.

The dissertation work of Assoc. Prof. Dobrikov is developed with the financial support and in connection with the implementation of 8 contracts, 5 of which were financed by the Scientific Research Fund of Bulgaria (Dobrikov is supervisor of 4 of them) and one each financed by COST, the National Research Fund of Russia and EC Operational Program "Science and Education for Smart Growth".

Assoc. Prof. Dobrikov has submitted a list of 303 citations on all his publications, excluding the citations included in his PhD dissertation. According to Scopus, a total of 286 citations (without self-citations of all authors) with h index = 10 are registered on all the scientific works of Assoc. Prof. Dobrikov. The citations on the publications included in the dissertation work are 28.

8. Assessment of the personal contribution of the author

All publications of Assoc. Prof. Dobrikov included in the dissertation are collective, and most of them have a significant number of co-authors (from 7 to 17), which is obviously mainly due to the multidisciplinary nature of their content. Regardless of the large number of co-authors, the personal contribution of Assoc. Prof. Dobrikov to the results obtained in the scientific works with his participation is indisputable, since the subject matter of most of them is a kind of continuation of his PhD dissertation under the supervision of Prof. V. Dimitrov. In addition, on 5 out of all 8 scientific publications, Assoc. Prof. Dobrikov is a corresponding author (two publications with Q1 and three with Q2).

9. Abstract

The extended abstract correctly reflects the main scientific contributions of the Assoc. Prof. Dobrikov's DSc dissertation.

10. Critical remarks and recommendations

A list of used abbreviations is missing, which greatly complicates the understanding of the content of the dissertation.

After examining the first group of 12 analogues of the diaryl ether MDL-860 for antiviral activity, it was concluded that the 2-cyano-4-nitrophenoxy group is a major building block for the existence of antiviral activity of this class of compounds. Furthermore, the active compounds contain two to three halogen atoms in the second aromatic ring, and a loss of efficiency was found when the bridging oxygen was replaced with another heteroatom (N, S) as well as when the aryl moiety was replaced with different heterocycles and the halogens were replaced with other

substituents in the second aromatic core. The question arises, why a significant part of the further synthesized 125 analogues of the diaryl ether MDL-860 do not conform structurally to the above conclusion?

It is not clear why the diaryl ether MDL-860 was chosen as the reference compound in the study of the antiviral activity of products 554-607, since it was inactive against half of the viruses in the study. What is the basis of the claim that compounds 555 and 556 are remarkably active against human coronavirus and adenovirus, respectively?

11. Personal impressions

As a reviewer of Assoc. Prof. Dobrikov's PhD dissertation, I have excellent impressions of his scientific activity and productivity. I have no other impressions outside of the current procedure.

12. Recommendations for future use of dissertation contributions and results

It would be good to focus future efforts mainly on synthetic modifications to improve the water solubility of the dissertation compounds, as well as to look for opportunities to impart water solubility in order to facilitate membrane transport, thanks to which interesting results can be expected from the biological tests. A suitable approach in this direction would be to use nanoscale self-assembling micelles using well-defined polymers containing hydrophobic and hydrophilic parts in their chains.

CONCLUSION

The dissertation contains scientific and scientific-applied results, which represent an original contribution to science and meet all the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria (LDASRB), the Regulations for the Implementation of the LDASRB and the Regulations for the Implementation of the LDASRB of the Bulgarian Academy of Sciences. The presented materials and dissertation results fully comply with the specific requirements of the Regulations of the Institute of Organic Chemistry with Centre of Phytochemistry – Bulgaria Academy of Sciences for the application of LDASRB.

The dissertation work shows that Assoc. Prof. Georgi Dobrikov possesses in-depth theoretical knowledge and professional skills in the scientific specialty “Organic Chemistry” by demonstrating qualities and skills for conducting research with obtaining original and significant scientific contributions.

Due to the above, I confidently give my positive assessment of the conducted research, presented by the above-reviewed dissertation work, abstract, achieved results and scientific contributions, and I recommend to the honorable Scientific Jury to award the scientific degree “Doctor of Sciences” to Assoc. Prof. Dr. Georgi Milchev Dobrikov in the field of higher education: 4. Natural sciences, mathematics and informatics, Professional area 4.2. Chemical Sciences (Organic Chemistry).

01.09.2023
Sofia, Bulgaria

Reviewer:

Prof. Eng. Vladimir Bojinov, DSc
Corresponding Member of BAS