

Scientific opinion

БЪЛГАРСКА АКАДЕМИЯ НА НАУКИТЕ
ИНСТИТУТ ПО МИКРОБИОЛОГИЯ
СТЕФАН АНГЕЛОВ
№ 797/24 09 24 г.
СОФИЯ

By: Prof. Dr. Penka Mladenova Petrova, Department of General Microbiology, Stefan Angelov Institute of Microbiology - BAS

for Ph.D. Thesis of Assistant Professor Marieta Dimitrova Belcheva on

Topic: New photosensitizers and carbon composites as antimicrobial agents

to obtain the Educational and scientific degree PhD in the field of higher education:

4. Natural sciences, mathematics, and informatics, professional direction: 4.3. Biological Sciences, Speciality: Microbiology

1. Relevance of the topic and general data for the dissertation work

Maxillofacial surgery and dentistry require knowledge not only in the field of medicine but also in chemistry, materials science, and microbiology. Pathogenic microorganisms cause inflammatory diseases such as dental infections (caries, pulpitis, periodontitis), and infections of mucous membranes, sinuses, salivary glands, and lymph nodes. Most often, such diseases are treated with antibiotics of different classes: beta-lactam (penicillin, methicillin), macrolide (erythromycin), and fluoroquinones (ciprofloxacin, levofloxacin). The growing antibiotic resistance of pathogenic bacteria and fungi, however, necessitates the search for new approaches in dentistry.

Photodynamic therapy is a new approach, where natural or artificially synthesized photosensitizers serve to inactivate pathogens through photo-oxidative processes. Such compounds are phthalocyanine, and porphyrin, as well as synthetic non-porphyrin derivatives from the group of phenothiazines, methylene, and toluidine blue. Very often, for a better effect, it is necessary to combine photosensitizers with composites. Undoubtedly, the topic of the dissertation work is current, of great importance, and has wide future applications in medical practice.

The PhD thesis contains 143 pages with all necessary chapters – ‘Literature review’ (34 pages), ‘Materials and methods’ (19 pages), and ‘Results and discussion’ (52 pages).

The evidence is presented in 4 tables and 56 figures. A total of 304 literary sources are cited, incl. two Bulgarian monographs. A list of articles related to the topic and a list of citations to those articles is included at the end of the dissertation.

In the "Literature review" section, the clinically significant microorganisms, which were used as reference strains are characterized, and the types of photosensitizers and their mechanism of action are described. The overview is comprehensive and detailed and shows a good knowledge of the topic of the dissertation, and from it logically follows the aim of the work: the testing of antimicrobial activity of newly synthesized metal-containing phthalocyanine photosensitizers and carbon composites with two main applications: (1) as an alternative in the fight against infections in the maxillofacial region and (2) as antibacterial agents in air purification.

The "Materials and Methods" section is quite detailed and describes the clinical isolates used and the methods for synthesizing metal-carbon composites, metal-containing photosensitizers, etc. For this section, I feel that some of the structural formulas and detailed descriptions would have been more appropriate in the Results section. The applied methods are both classical microbiological and the latest in the field such as X-ray photoelectron spectroscopy, and scanning electron microscopy (SEM). Statistical analyses were performed where necessary.

Results and scientific contributions

In the dissertation, a large number of pathogens from the species *Staphylococcus aureus*, *Enterococcus faecalis*, *Candida albicans*, *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis*, *Prevotella intermedia*, *Escherichia coli*, *Streptococcus sanguis*, *Enterococcus faecalis*, *Streptococcus salivarius* were tested for sensitivity. Some of the clinical isolates are at the Faculty of Dental Medicine, MU – Sofia, and some such as *A. actinomycetemcomitans*, *P. gingivalis*, and *P. intermedia* are available thanks to the work of the PhD student at the University Medical Center in Groningen. This wide range of pathogens makes the study of new antimicrobial agents large-scale and exhaustive.

The dissertation has several novelties and contributions. The great potential of gallium phthalocyanine as a photosensitizer was revealed, and zinc phthalocyanine was most effective in pathogenic yeast treatment. The copper-containing composite has a very good potential for application as an antibacterial agent, and this action can be assisted by

the addition of activated carbon. There are 12 conclusions at the end of the presentation, followed by 6 contributions.

Remarks

I have no objections to the work. The experiments were carried out precisely and in a sufficient number of repetitions, richly illustrated with wonderful figures. I have a small complaint about the contributions, some of them are very general. E.g. contribution #5 is formulated so that it can be applied to the field of photosensitizers in general, and contribution #6 to the synthesis of antibacterial materials in general.

Dissertation Related Publications

There are three publications related to the topic of the dissertation, already published in authoritative journals with a total IF – 4.74, and the doctoral student is the first author in two of them. Articles already cited. The PhD student was a participant in two scientific projects related to the topic of the dissertation and is a co-author in five reports and posters presented at scientific conferences.

Conclusion

The presented work outlines assistant Marieta Dimitrova Belcheva as a long-term researcher with diverse knowledge in the fields of medical microbiology, pharmacy, organic chemistry, and materials science. Based on the novelties and achievements of the dissertation work and the indicators, I strongly recommend that she be awarded the scientific and educational degree "Doctor".

Signature:

**На основание
чл. 2 от ЗЗЛД**

/Prof. Penka Petrova, DSc/