Multifunctional Rhenium and Iridium Flavonoid Complexes for Antibacterial Biomaterials and Green Therapeutic Platforms

Jelena Poljarević,[a] Stefan Nikolić,[b] Ljiljana E. Mihajlović,[b] Ana Kandić,[b] Jörg Schachner,[c] Milan Milovanović, Monica Trif [d]

[a] *University of Belgrade – Faculty of Chemistry, Studentski trg 12–16, 11000 Belgrade, Serbia*
[b] *Innovation Center of the Faculty of Chemistry, Belgrade, Studentski trg 12–16, 11000 Belgrade, Serbia*
[c] *Institute of Chemistry, University of Graz, Schuberstr. 1, 8010 Graz, Austria*
[d] *Centre for Innovative Process Engineering (CENTIV) GmbH, Boschstr. 8–10, 28857 Syke, Germany*

INTRODUCTION

The rise of multi-resistant bacteria and biofilm-related infections demands new generation of antibacterial materials and innovative therapeutic agents.

Why metal-flavonoid complexes?

Flavonoids are natural, bioactive molecules with antibacterial, antioxidant, anti-inflammatory, and anticancer activities. [1]

Why rhenium & iridium?

Re and Ir complexes show diverse redox chemistry, catalytic activity, and increasing antibacterial potential. [2-4] Coordination to flavonoids can tune lipophilicity, stability, and biological performance.

Our work

We present Re(V) and Ir(III) flavonoid complexes (Figs. 1–5) as multifunctional platforms with potential for antibacterial biomaterials, surface coatings, and green therapeutic systems. [5]

LITERATURE BACKGROUND

Re complexes

- Re(I) tricarbonyl complexes active against Gram-positive bacteria, including *S. aureus* and *E. coli*. [6]
- Re complexes can inhibit biofilm formation and bacterial growth. [2]
- Tunable ligands influence activity, selectivity, and uptake.

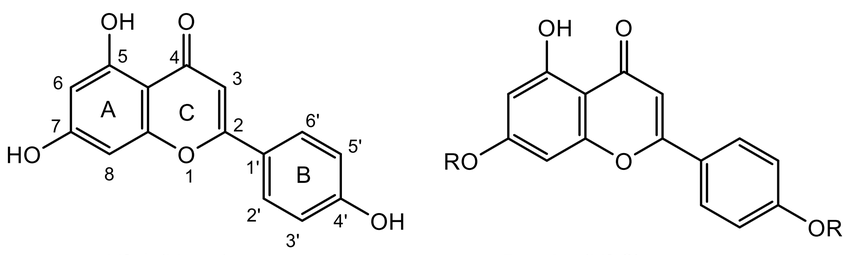
Ir complexes

- Ir(III) complexes show antibacterial and antibiofilm activity. [7]
- Recent Ir(III) tetrazolato complexes were active against planktonic cells and biofilms (e.g., *S. aureus, E. coli).* [8]
- Half-sandwich Ir complexes are promising due to stability and tunable coordination sphere.

Re/Ir flavonoid complexes combine metal-centred redox chemistry with natural bioactivity for innovative antibacterial solutions.

OUR CHEMICAL PLATFORM

Ligand derivatization strategy



H**L1** (Hapg)

R= -Ac (H**L2**)
R= -Si(tBu)Me_2 (H**L3**)
R= -Me (H**L4**)
R= -Bn (H**L5**)

Fig. 1. Structures of parent apigenin (H**L1**) and modified ligand structures (H**L2–5**). [5]

Re chemistry

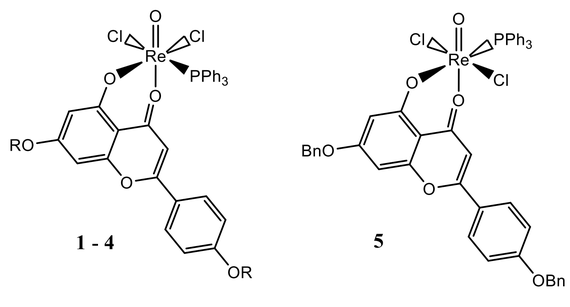


Fig. 2. Structures of synthesized Re(V) complexes (**1–5**).

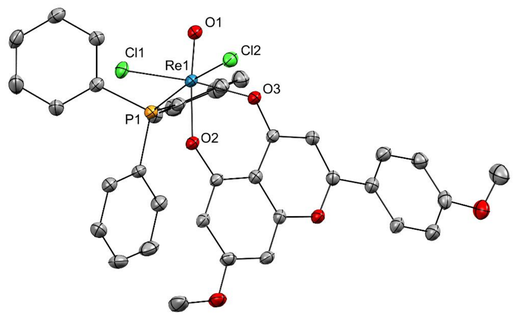


Fig. 3. Molecular structures of synthesized Re(V) complex **4**.

Ir chemistry

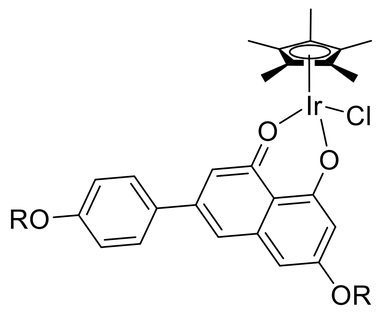


Fig. 4. Structures of synthesized Ir(III) complexes (**1–3**).

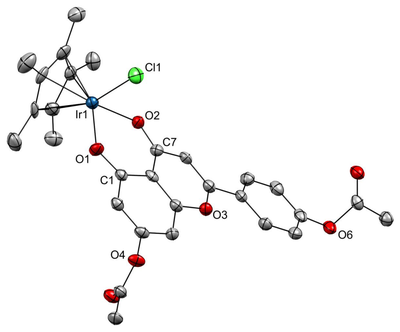
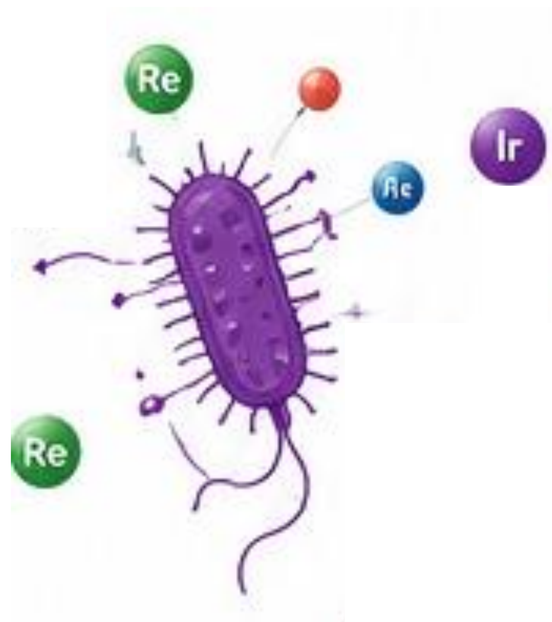


Fig. 5. Molecular structures of synthesized Ir(III) complex **2**.

RELEVANCE TO ANTIBACTERIAL BIOMATERIALS

How metal-flavonoid complexes can act against bacteria?

- Disruption of bacterial membranes
- Generation of ROS
- Enzyme inhibiton
- Interference with DNA replication
- Inhibition of biofilm formation
- Incorporation into polymeric matrices and hydrogels
- Release-controlled platforms for sustained action.



REFERENCES

[1] Lj. E. Mihajlović, M. Trif, M. B. Živković, Inorganics 2025 (13) 250.
[2] F. Zobi, G. Demirci, M. Rasic, Helv. Chim. Acta 2026 (109) e00221.
[3] F. E. Kühn, W. A. Herrmann, 2000 (97) 220. Springer, Berlin, Heidelberg.
[4] F. Wang, J. Wu, Y. Chen, et al. Chem. Euro. J. 2026 (32) e00022.
[5] M. R. Milovanović, S. R. Nikolić, A. Dupé, J. A. Schachner, Lj. E. Mihajlović, Dalton Trans. 2025 (54) 11047.
[6] A. Frei, M. Amado, M. A. Cooper, M. A. T. Blaskovich, Chem. Eur. J. 2020 (26) 2852.
[7] G. D. Fallon, et al. J. Photochem. Photobiol. A: Chem. 2025 (462) 116218.
[8] Y. Lu, X. Zhang, M. Song, H. Xie, S. Chen, Y. Zhou, J. Jia, H.Tang, RSC Advances 2025 (15) 2329.

Acknowledgements

This work was financially supported by the European Union's Horizon Europe program under: the Marie Skłodowska-Curie Actions grant agreements No. 101086373 (MET-EFFECT) and No. 101131441 (VALIAS); and No. 101036768 (PROMISEANG) funded from the Bio Based Industries Joint Undertaking (JU), and the Ministry of Science, Technological Development and Innovation of Republic of Serbia, contract numbers 451-03-33/2026-03/200168 and 451-03-33/2026-03/200288. The authors also gratefully acknowledge support from NAWI Graz.

Funded by the European Union