

Mikroalgen im LED-Scheinwerferlicht:

Lichtgestützte Biosynthese von Wertstoffen

FTI – Netzwerk Algen 2025

Prof. Dr. Harald Schöbel

MCI | Die Unternehmerische Hochschule[®]

Outlook

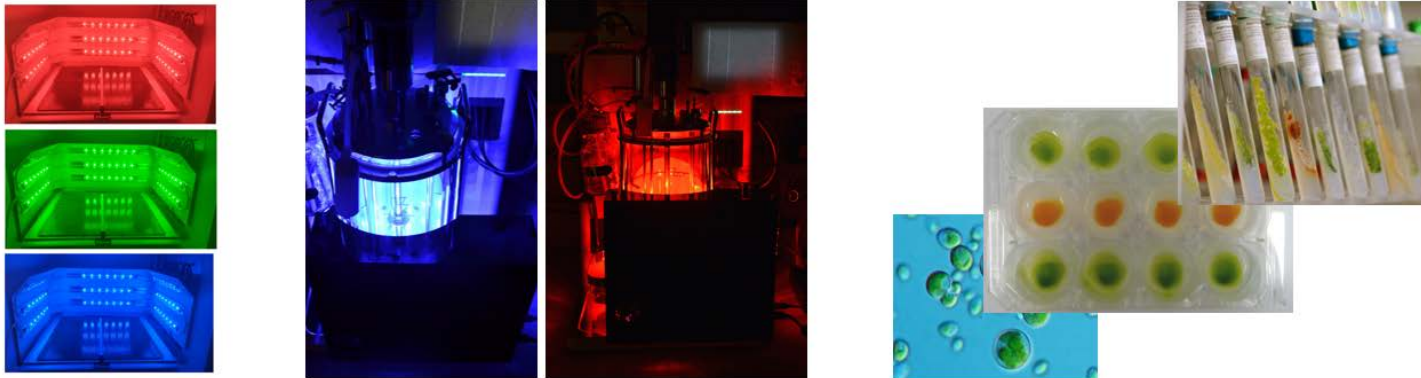
- Motivation
- Light Stress in Microalgae
- Light mediated biosynthesis of metal nanoparticles



Motivation

Optical Engineering + Microalgae

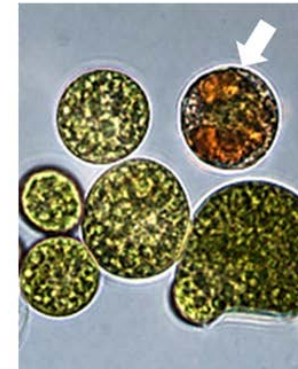
- tailor made LED based irradiation systems
- ASIB 505 culture collection: soil-, airborne and lichen algae (Botanical Institute of the University of Innsbruck, Austria)



Light Stress in Microalgae

Setup

- UV-A light stress to terrestrial microalgae
- irradiation for 24 h, 48 h and 72 h (+24 h) with $\bar{I} = 50 \frac{\text{mW}}{\text{cm}^2}$
- 5 strains from *Chromochloris zofingiensis*, *Coccomyxa* and *Diplosphaera* (from Botany, UIBK)

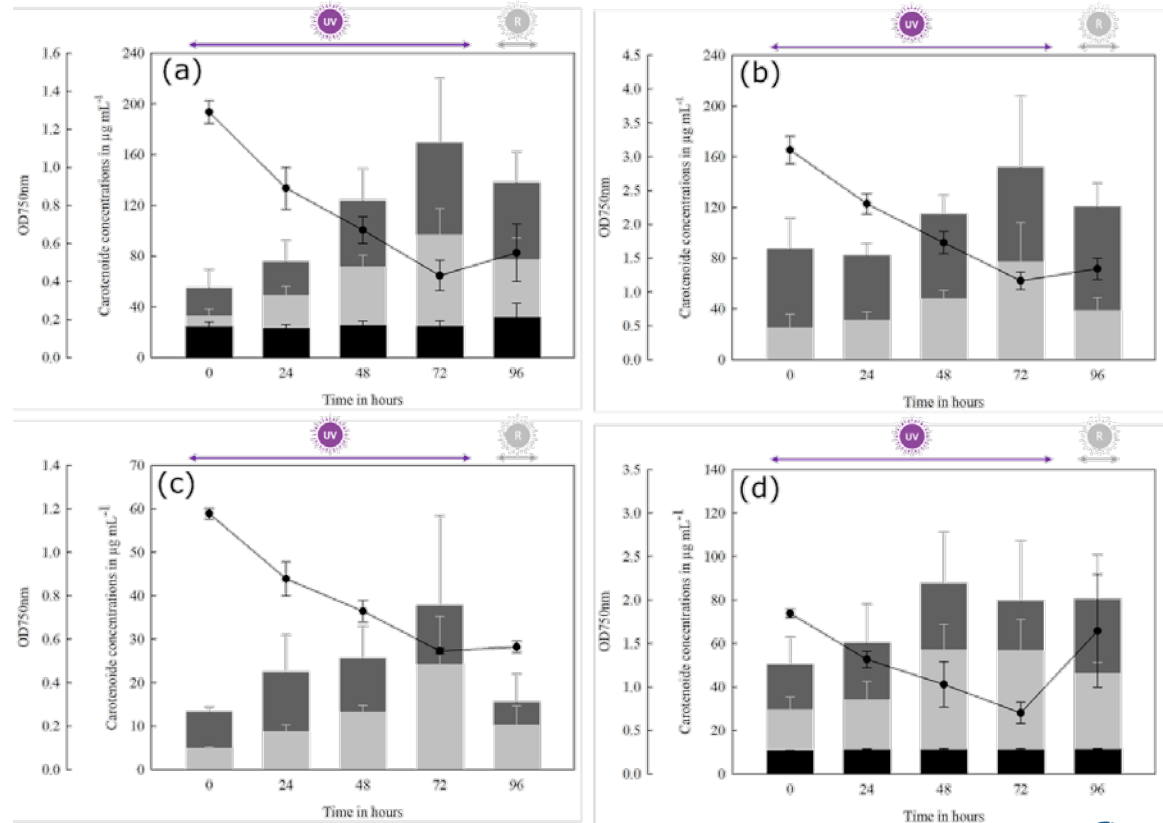


from Mutschlechner et al. 2022

Light Stress in Microalgae

Results

- enhanced carotenoid production under UV-A light stress

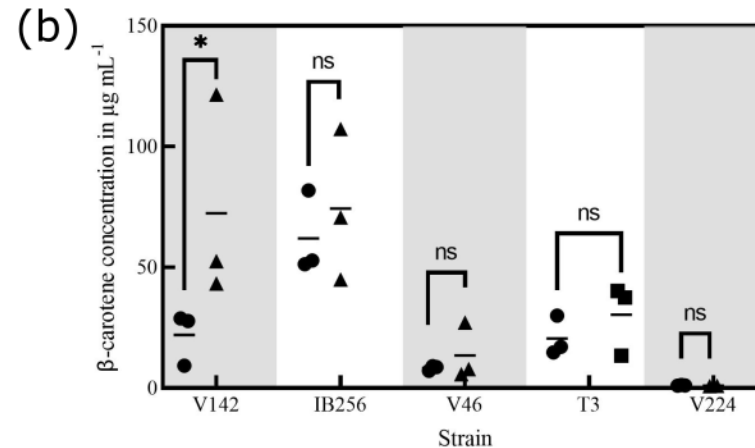
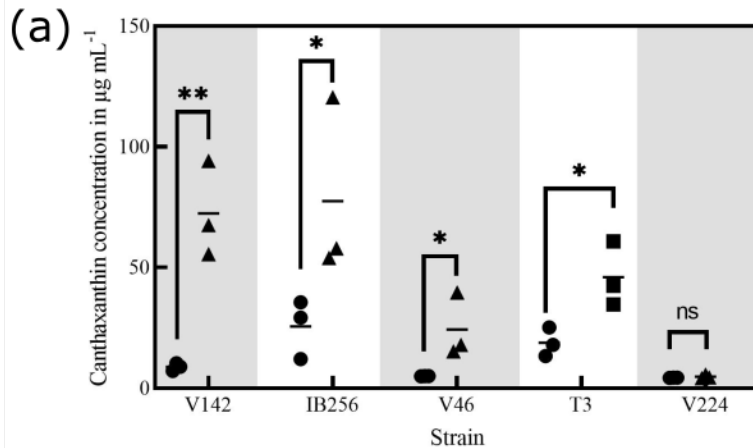


from Mutschlechner et al. 2022

Light Stress in Microalgae

Results

- enhanced canthaxanthin production in four out of five strains
- enhanced β -carotene production in four out of five strains



● 0 h (no UV-A)
 ■ 48 h UV-A
 ▲ 72 h UV-A

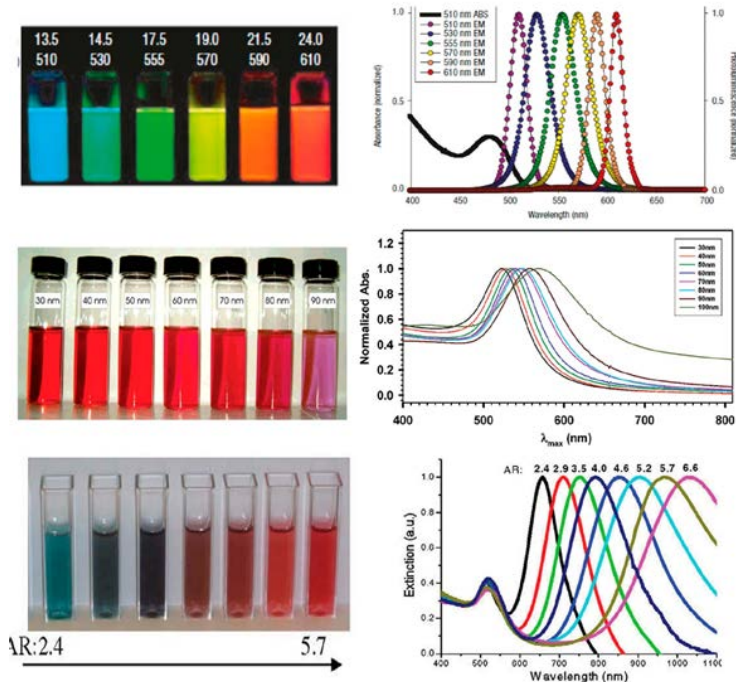
from Mutschlechner et al. 2022

Light mediated biosynthesis of metal nanoparticles

Motivation

■ Nanoparticle size depending properties

- Antimicrobial activities
- Catalytic activities
- Thermal conductivity
- Chemical resistance
- Optical performance
- Electrical properties

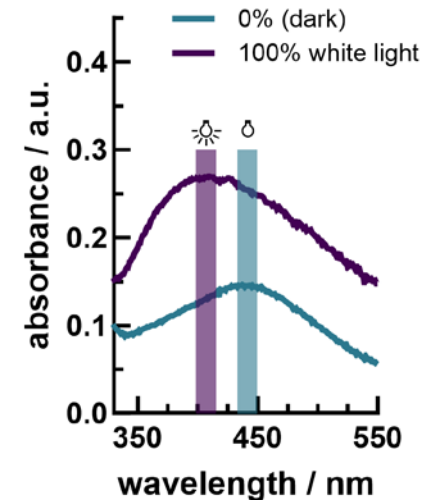


Dolai, Mandal et al. 2021 - Nanoparticle Size Effects in Biomedical
<https://doi.org/10.1021/acsanm.1c00987>

Light mediated biosynthesis of metal nanoparticles

Motivation

- biosynthesis of metal nanoparticles with CFE of yeast
- irradiation vs. dark synthesis
- significant impact of light on resulting NPs

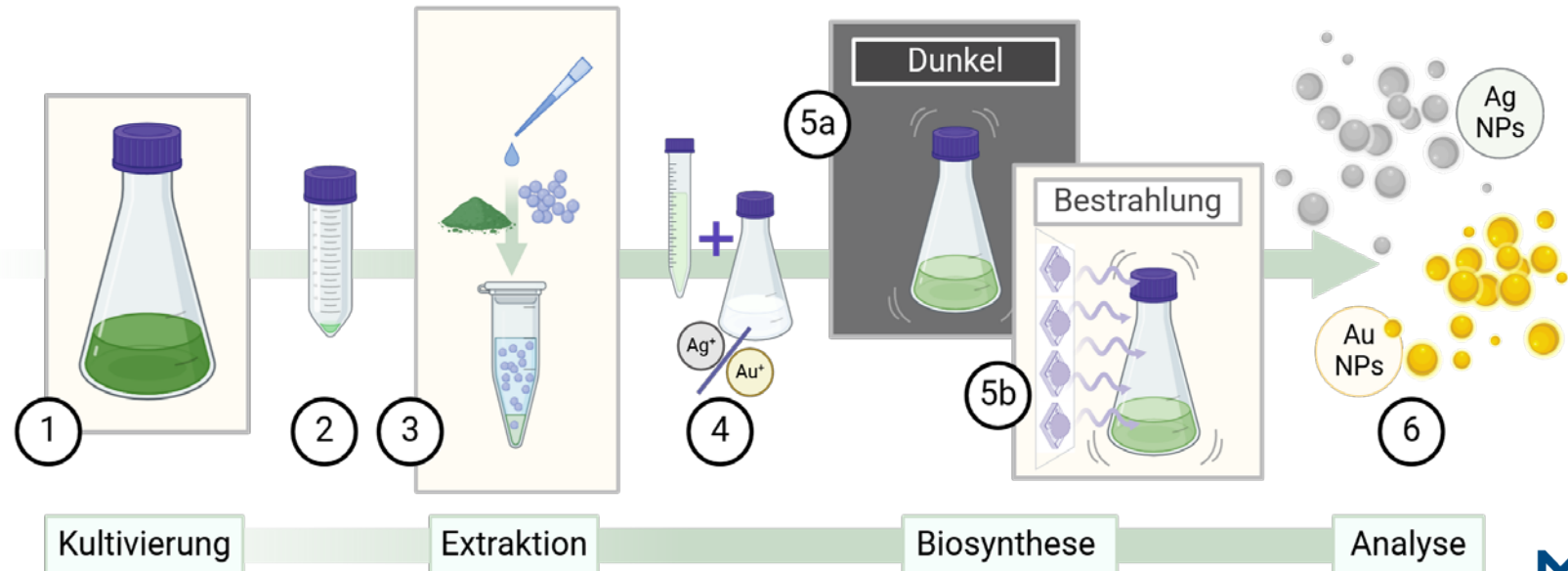


from Colleselli et al. 2023b

Light mediated biosynthesis of metal nanoparticles

Method

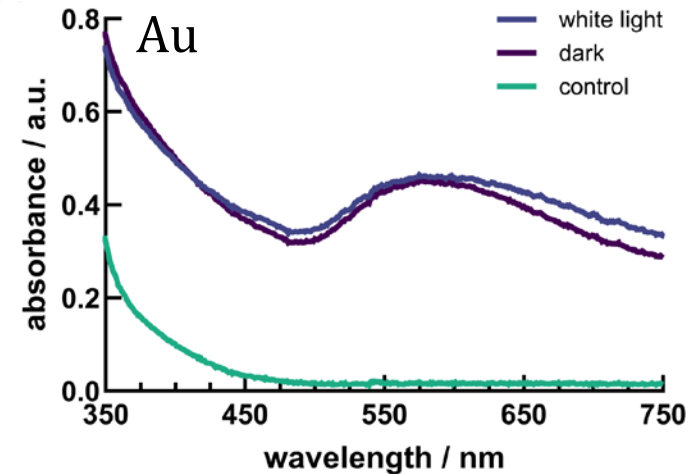
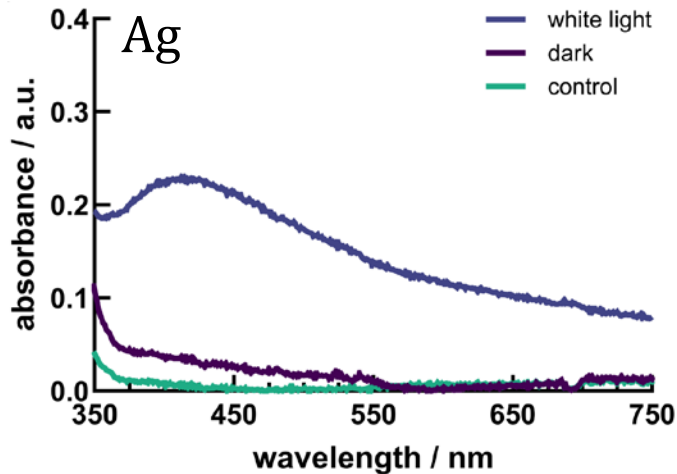
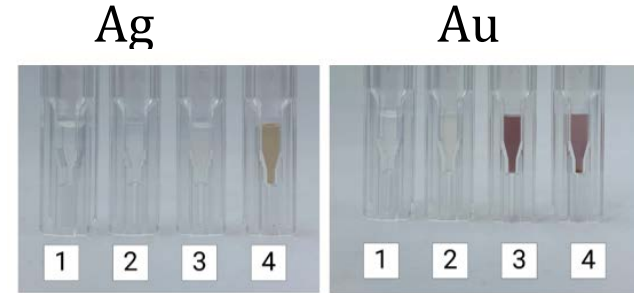
- screening 5 different strains for potential Ag and Au NP biosynthesis



Light mediated biosynthesis of metal nanoparticles

Results

- biosynthesis successful
 - color change
 - typical UV-VIS spectra



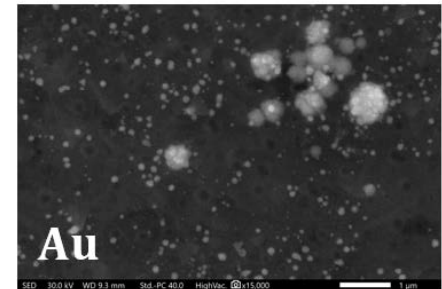
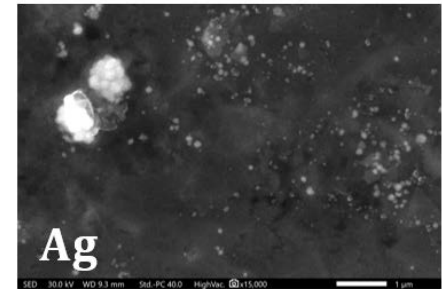
from Colleselli et al. 2025

Light mediated biosynthesis of metal nanoparticles

Results

- microalgae show potential for NP biosynthesis
 - 5 different strains (*Coccomyxa*, *Chromochloris* und *Diplosphaera*)

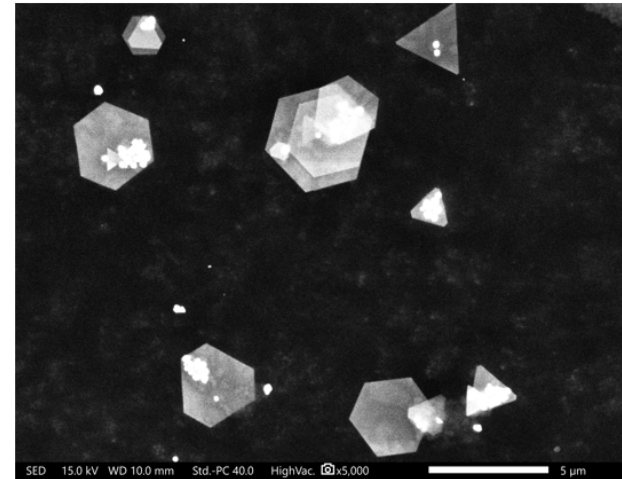
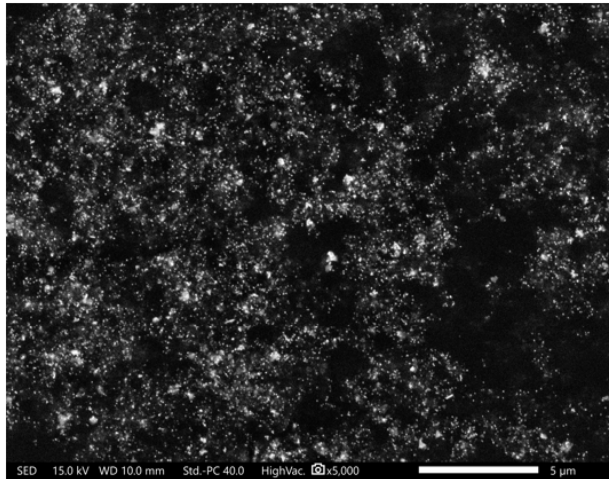
strain	Silver NP		Gold NP	
	dark	light	dark	light
IB 256	✓	✓	✓	✓
T 3	✓	✓	✓	✓
V46	✓	✓	✓	✓
V 142	✗	✓	✓	✓
V 224	✗	✓	✓	✓



Inducing biosynthesis in microalgae

Results

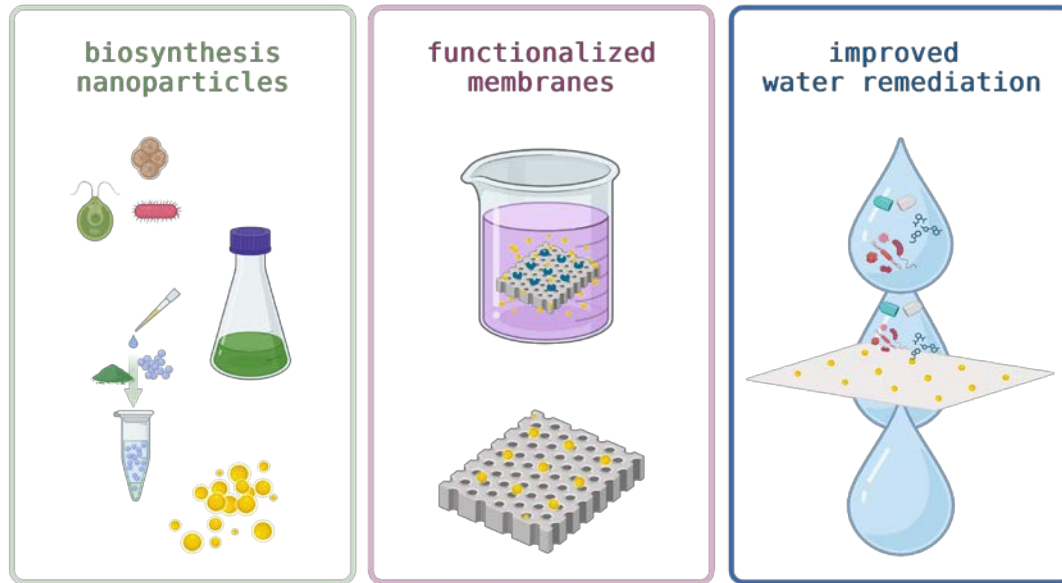
- depending on cultivation different NPs



Light mediated biosynthesis of metal nanoparticles

Outlook

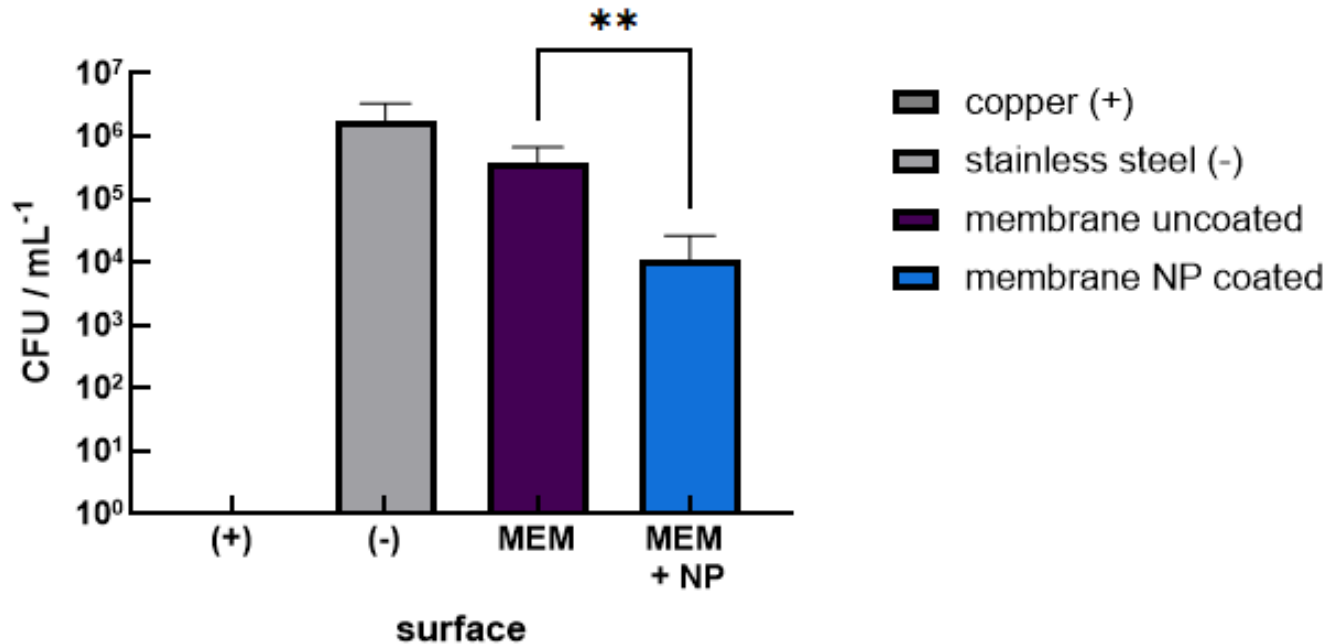
- anti-biofouling membranes for water remediation



Light mediated biosynthesis of metal nanoparticles

Outlook

- anti-biofouling membranes for water remediation



Summary

Microalgae in the LED Spotlight: Light-Assisted Biosynthesis of Valuable Substances

- Optical engineering tools can help to better characterize the present light regime
 - Light stress can induce and enhance the production of products with microalgae
 - Microalgae have the potential to biosynthesize metal nanoparticles.
- **Light can be a powerful tool in biotechnology.**

Sources

M. Mutschlechner, A. Walter, L. Colleselli, C. Griesbeck, H. Schöbel. **Enhancing carotenogenesis in terrestrial microalgae by UV-A light stress.** *Journal of Applied Phycology* **34**, 1943–1955 (2022) doi: 10.1007/s10811-022-02772-5

L. Colleselli, B. Siewert, P. Vrabl and H. Schöbel. **Optical Simulations in LifeSciences: Benefiting from ray-tracing in biophotonics and photobiology.** *Optics Communications* **552**, 130028 (2024) doi: 10.1016/j.optcom.2023.130028

L. Colleselli, M. Mutschlechner, M. Spruck, P. Vrabl, S. Zeilinger-Migsich and H. Schöbel. **Light-mediated biosynthesis of size-tuned silver nanoparticles using *Saccharomyces cerevisiae* extract.** *Bioprocess and Biosystems Engineering* **47**, 1669–1682, (2024) doi: 10.1007/s00449-024-03060-x

L. Colleselli, M. Mutschlechner, M. Spruck, P. Vrabl, S. Zeilinger-Migsich and H. Schöbel. **The Potential of light-induced biosynthesis of nanoparticle with microalgae.** *in preparation* (2025)

Thank you

Team



Funding



Collaborations



Microalgae in the LED Spotlight: Light-Assisted Biosynthesis of Valuable Substances

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Vienna, Austria

Thank you for your attention!

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