Integrated bioprocess design for the production of tailor-made biosurfactants: application testing

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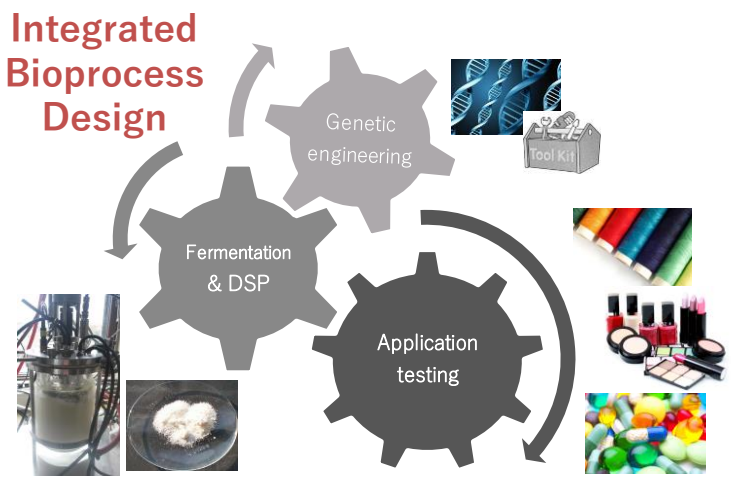
Introduction

With an annual production of 13 million tons worldwide, it is clear that surfactants are very important performance molecules. An emerging class of surfactants are the **biosurfactants (BS)** produced by microorganisms, offering a **more environmentally friendly** alternative compared to the traditional (petrochemically produced) surfactants. Unfortunately, there are some factors that have hindered the real market penetration of BS up until today, like limited structural variability, the production of mixtures, and often low productivities. One type of glycolipid BS are **sophorolipids (SLs)**, naturally produced by the non-pathogenic yeast ***Starmerella bombicola*** in high amounts (> 200 g/L), explaining its large industrial interest. This non-pathogenic yeast can be genetically engineered to alter the production towards one specific tailor-made BS (for example **bolaform SLs**), transforming *S. bombicola* into a real **platform organism**. In this research, an **integrated bioprocess design** strategy is developed, covering the whole innovation chain from genetic engineering to fermentation and downstream processing (DSP), to final application testing for the production of new types of BS produced by *S. bombicola*.

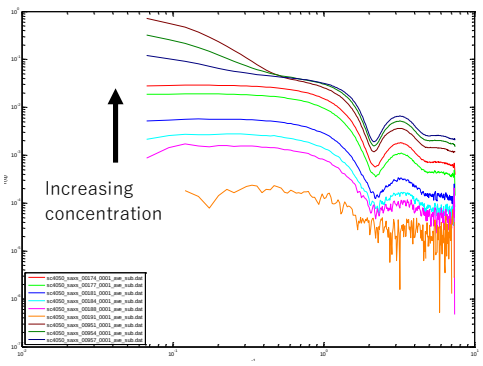


Methods

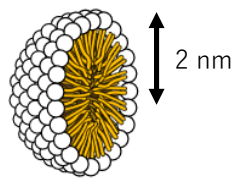
Application research is performed together with different research partners, to identify possible applications of the tailor-made molecules ranging from cosmetics to pharmaceuticals, and so on. In cooperation with LCMCP, the **self-assembly** of bolaform SLs was studied using SAXS-data gathered at the European Synchrotron Radiation Facility (ESRF). Further on, their potential usage in **sol-gel chemistry** and **nanoparticle synthesis** was also investigated. In cooperation with GhEnTox lab, the **exotoxicity** of various tailor-made BS was also investigated. **Antimicrobial properties** were also assessed.

Results

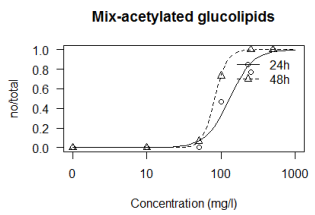
Self-assembly of bolaform SLs in water (ESRF)



SAXS data: micelle formation

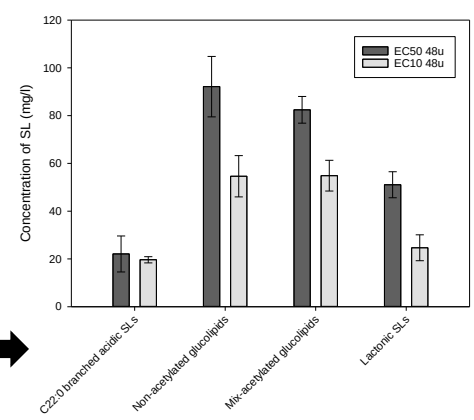


Ecotoxicity tests: acute toxicity on ***Daphnia magna*** (OECD 202)



Dose-response curve (example)

EC50/EC10



The higher EC, the less toxic

Acidic and bolaform SLs gave no immobilisation effect: NOAEL>400mg/L

Commercial surfactants (ECHA):
SDS: LC50 = 3.15g/L
APG: EC50 =150g/L

Sol-gel chemistry using bolaform SLs in water

Using tetraethyl orthosilate (TEOS) as silica precursor: very porous structures obtained

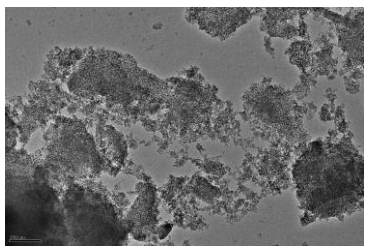
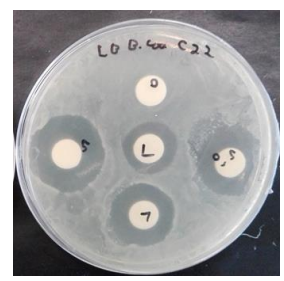


Image from Transmission Electron Microscope (TEM)

Antimicrobial properties: disk diffusion method

	Lactonic SLs	Non-acetylated acidic SL	Acetylated acidic SL	Non-acetylated glucolipid	Acetylated glucolipid	Symmetrical bolaform SL	Asymmetrical bolaform SL	C22 branched SL (*R. bogoriensis*)
E. coli	+	-	-	-	-	-	-	-
S. aureus	+	-	-	-	-	-	-	+
B. coagulans	+	-	-	-	-	-	-	+
P. aeruginosa	-	-	-	-	-	-	-	-
S. bombicola	-	-	-	-	-	-	-	-
C. albicans	-	-	-	-	-	-	-	-
S. cerevisae	-	-	-	-	-	-	-	-
A. niger	-	-	-	-	-	-	-	-
U. maydis	-	-	-	-	-	-	-	-



B. coagulans inhibition

Conclusion

The application testing revealed interesting properties for the BS molecules, as the low ecotoxicity towards dapnids and algea, as well as their good biodegradability. In the end of this research, a portfolio of purified tailor-made BS will be obtained, each one displaying its own unique characteristics. The latter will lead to an **improved market penetration** of biosurfactants in the future.

Acknowledgements

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