Investigating the interaction between microbial glycolipids and bio-mimetic membranes

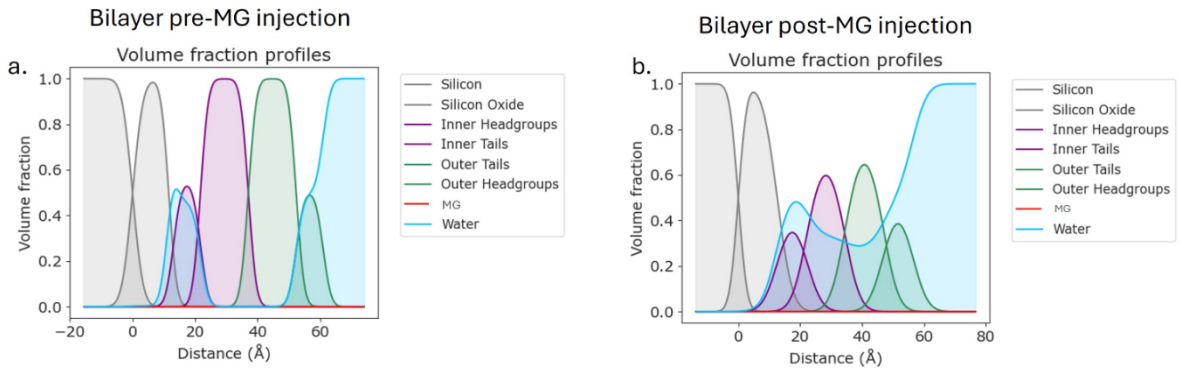
Margherita Recanatini[ab], Javier Carrascosa-Tejedor[b], Ingo Hoffmann[b], Nicolò Paracini[c] and Niki Baccile[a]

[a]Centre National de la Recherche Scientifique, Laboratoire de Chimie de la Matière Condensée de Paris, LCMCP, Sorbonne Université, F-75005 Paris, France
[b]Institut Laue-Langevin, 71 avenue des Martyrs, CS20156, 38042, Grenoble, Cedex 9, France
[c]Copenaghen University - Pharmacy Department, Universitetsparken 2 2100, Copenaghen, Denmark

margherita.recanatini@sorbonne-universite.fr

Microbial glycolipids (MGs) are bio-based amphiphiles composed of a hydrophilic sugar head covalently bonded with fatty acid chain confering them amphiphilic and surfactant properties with a physicochemical behaviour depending on temperature, pH and type of metal ion present in solution. The colloidal and surfactant activities of MGs have been extensively studied and compared with conventional surfactants [1], highlighting their potential as promising and innovative bio-based lipidic material for cosmetic formulation and drug encapsulation. Although numerous studies have investigated the effect of MGs over bio-membrane phospholipids in relation to their antimicrobial effects, the actual physicochemical mechanism governing their interaction with bacterial membranes remain poorly explored. In this work, we investigate the interaction between biomimetic membranes and MGs from a structural and interfacial perspective, to address current knowledge gaps in the mechanism driving MGs antimicrobial activity. Four different MGs (glucolipid G-C18:1, acetylated acidic sophorolipid SL C18:1, monorhamnolipid mono-RL, di-rhamnolipid di-RL) were tested to compare their effects on the biomimetic membrane composed by different lipidic composition and ratios between 1,2-dioleoyl-sn-glycero-3- phosphocholine (DOPC), 1,2-dioleoyl-sn-glycero-3-phosphatidylglycerol (DOPG), N-octadecanoyl-D-erythro-sphingosylphosphorylcholine (SM) and cholesterol (Chol). Specifically, three different membranes models were tested: DOPC, DOPC:DOPG 75:25 and DOPC:SM:Chol 2:2:1. Since it is reported that MGs structural, self-assembly and interfacial properties strongly depend on the pH [2], each MG has been dissolved in water at different pHs to obtain vesicles or micelles suspensions. We explored the interaction of MGs with supported lipid bilayers using interfacial analysis at the solid/liquid interface by using Quartz-Crystal Microbalance with Dissipation monitoring (QCM-D) system and Neutron Reflectivity (NR) with MGs both in vesicles and micelle formulation. QCM-D results have showed that, all four MGs produce effect in the structure of bilayers, resulting in a loss of lipid material. The strongest effect was observed with G-C18:1 and mono-RL vesicles, whereas a smaller impact was provided by SL C18:1 micelles. Our findings, supported by NR experiments, indicate that MGs are responsible for removing a substantial portion of the bilayer, significantly lowering its coverage (Figure 1).

Keywords:
Antimicrobial, Biosurfactant, Interface, Solid/Liquid, Biomembranes



Volume fraction profile of supported DOPC bilayer before (a.) and after (b.) the interaction with MGs vesicles obtained with NR

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