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Effects of violacein on the organization of lipids in a model cell membrane

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1 Introduction

Violacein is a bis indole purple pigment found in several gram-negative bacteria such as *Chromobacterium violaceum* and *Duganella violaceinigra*. This molecule produced by the bacteria helps them to kill the surrounding gram-positive bacteria. Because of its innate antibacterial properties, researchers have tried to extract violacein from the occurring bacteria and check its applicability in the therapeutic paradigm. Apart from being antibacterial, studies on various cell lines have proved violacein to have anti-tumor and antiviral activities. Multiple approaches have been taken over the past few years to determine the underlying mechanism of interaction of violacein with various cells. The work of Aruldass et al. suggested that violacein alters the morphology of *S. aureus* [1]. Although other pathways have also been proposed for the violacein-cell interaction, the present study focuses on the effect of violacein on the cellular membrane. Here, three different lipids (zwitterionic, cationic and, anionic) were taken into consideration to understand the role of electrostatics in the violacein-membrane interaction.

2 Experiment

1,2-dipalmitoyl-sn-glycero-3-phosphocholi-ne (DPPC, zwitterionic), 1,2-distearoyl-sn-glycero-3-ethylphosphocholine chloride salt (DSEPC, cationic), and 1,2-dipalmitoyl-sn-glycero-3-phospho-rac-(1-glycerol) sodium salt (DPPG, anionic) lipids were used to form multilayers on Si (100) substrate. Grazing incidence X-ray diffraction (GIXD) measurements were performed on pure lipids and lipids with added violacein multilayers. The measurements were performed at a relative humidity of 98%.

3 Results and Discussions

The obtained 2D diffraction patterns as shown in Fig 1 were deconvoluted into intensity v/s parallel momentum transfer vector (q_{xy}) and intensity v/s perpendicular momentum transfer vector (q_z) which give information about in-plane and out-of-plane ordering of lipids in the membrane, respectively. Variation of intensity with q_{xy} and q_z with the addition of violacein to DPPC multilayers is shown in Fig 2. It was found that the addition of violacein to DPPC and DSEPC membrane leads to a decrement in lattice parameters and tilt angle of lipid chain suggesting strong compactness in the membrane [2]. In contrast, the addition of violacein to DPPG multilayers did not cause any significant change.

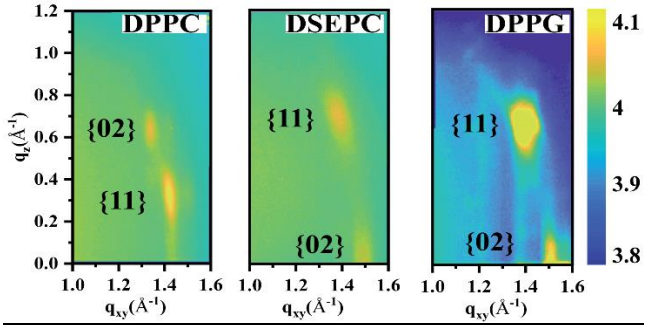

Figure 1. Grazing incidence diffraction pattern from the lipid multilayers deposited on Si substrate. The peaks are indexed considering body-centered rectangular lattice. For DPPC multilayers, the presence of two peaks for $q_z>0$ is indicative of the next nearest neighbor tilt in the molecules. For DSEPC and DPPG, one of the two peaks is at $q_z= 0$ which suggests a nearest neighbor tilt in the molecule. The figure is adopted from reference [2].

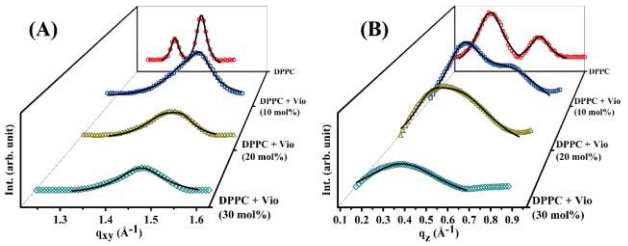

Figure 2. Deconvoluted (A) intensity v/s q_{xy} and (B) intensity v/s q_z from the 2D image of DPPC and DPPC with added violacein multilayers. The figure is adopted from reference [2].

4 Conclusions

The present study sheds lights on the interaction of violacein with a model cellular membranes made up of differently charged lipids. The addition of violacein thickens the neutral (DPPC) and positively (DSEPC) charged lipid layers whereas the anionic lipid (DPPG) remains almost unaffected.

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References

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[2] Gupta, R. et al., BBA - Biomembranes 1863, 183647 (2021).

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