The effect of chitosan on the thermodynamic properties of mixed Chol/SPAN-Tween20 monolayers

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Chitosan is a natural polysaccharide derived from chitin, used for biomedical applications and in pharmaceutical and biotechnology industries, as fat reduced, bactericide agent and wound healing material and coating agent for stabilization of vesicular systems [1]. In all these uses, its interesting properties such as biocompatibility, biodegradability and non-toxicity are exploited. While the efficacy for some of them is proven, little is known about the molecular-level interactions involved in these applications. More interestingly, owing to its cationic character in acidic solutions, chitosan may interact with the negatively charged surface of biomembranes, and therefore understanding such interactions is important for its use. In this work we have employed Langmuir monolayers as membrane model to probe the interactions of chitosan with monolayers formed by Tween20 or Span20 non-ionic surfactants, mixed to Cholesterol and anionic DCP, to mimic the composition of niosomal vesicles whose efficacy as drug delivery systems has been widely explored [2]. The aim of this investigation is to elucidate the controlling factors useful for a rational design of a chitosan-coated drug delivery system and understand in which conditions chitosan decoration of the vesicle can improve the niosomal structural properties and drug delivery efficiency.

The surface pressure–area isotherms of equimolar Span 20/Chol and Tween 20/Chol monolayer have been measured at 25°C. Chitosan was dissolved in acetate buffer solution (0.03 M, pH 4.5) at different concentrations up to 0.45 mg/mL, where it is not surface-active. To understand the role of the different forces involved in the polycation-monolayer interaction, we also considered the effect of the addition of the anionic lipid Dicetylphosphate (DCP) to form charged Tween20/Chol/DCP films, with molar ratio 1/2/1. Our study revealed that chitosan strongly adsorbed at monolayers surface inducing a film expansion both at low and at high surface pressure, where it interacts not only superficially but also inserted to a certain degree into the film. In certain conditions, depending on both chitosan concentration and on the different hydrophilic-hydrophobic balance of the surfactants, modification of the monolayer phase transition has been observed. Elucidating the molecular organization of chitosan-surfactant monolayers could be useful to better understand the release rate of model drugs from niosomes.

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