Interaction between silver and gold nanoparticles with lipid Langmuir monolayers as cell membrane models

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Abstract

The present study shows the results obtained from the analysis of the interaction between gold and silver nanoparticles with Langmuir films built from DPPC, DPPG and DODAB lipids on aqueous subphase in order to mimic cell membranes of bacteria and fungi. The nanoparticles were incorporated in the aqueous subphase of the monolayers, which were compressed until collapse. The films were characterized with tensiometry and infrared spectroscopy, by which a condensation of the monolayer could be noted. The results show an intrinsic interaction of the nanoparticles with the lipids at the air-water interface, which may give important information on the molecular mechanism on how these nanoparticles act on cell membranes.

Introduction

Recent studies in nanotechnology applied to chemistry and pharmacy has shown a great improvement. Among these progresses we can cite the use of metallic nanoparticles in the treatment of infections caused by microorganisms, since such compounds show strong inhibitory and bactericidal effect when used in medical or hygiene products.
Since the knowledge about the molecular mechanism involved in the interaction between metallic nanoparticles and cell membranes of microorganisms is scarce, the use of lipid Langmuir films as cell membrane models can give new information on this issue.
In this present work we investigated the interaction between silver and gold nanoparticles stabilized with polyvinylpropylene (PVP) with Langmuir monolayers composed of selected lipids: dipalmitoyl phosphatidyl choline (DPPC), dipalmitoyl phosphatidyl glicerol (DPPG), and dioctadecyl dimethylammonium bromide (DODAB) using surface pressure-area isotherms and polarization modulation infrared reflection-absorption spectroscopy (PM-IRRAS).

Results and Discussion

The effect caused by the incorporation of both nanoparticles (Ag and Au) in all monolayers (DPPC, DPPG and DODAB) was the condensation of the molecular film, as observed on **figure 1** for the DPPC. PM-IRRAS spectra showed that the nanoparticles affect both regions of the lipid: hydrophobic (alkyl tails) and hydrophilic (polar head), indicating the present of the nanoparticles in the monolayer, but a strong effect is observed on the polar head groups of the lipid.

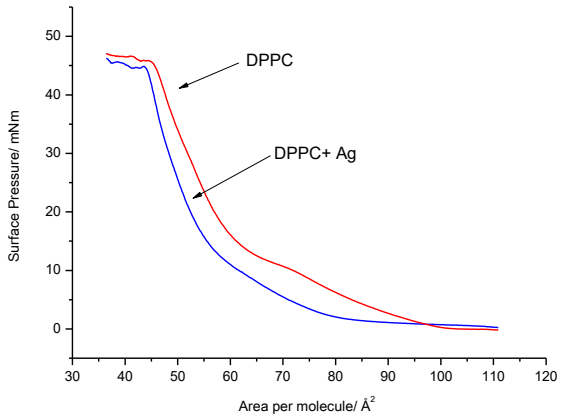

Figura 1. Surface pressure isotherm for DPPC in presence of silver nanoparticle (blue chart) and in the absence of silver nanoparticle (red chart).

Conclusions

Both nanoparticles (Ag and Au) can be incorporated in Langmuir monolayers of DPPC, DPPG and DODAB condensing the monolayer. These interactions affect the polar head group of the lipid altering the degree of packing of the hydrophobic tails. These results could be an important impact on the comprehension on the molecular mechanism of interaction between nanoparticles and cell membranes of fungi and bacteria.

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