Dynamical heterogeneity in the model brain lipid membrane due to NSAIDs

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Nonsteroidal anti-inflammatory drugs (NSAIDs) are one of the most prescribed drugs for their analgesic, antiplatelet, anti-inflammatory, and antipyretic properties. NSAIDs have a strong propensity to alter the structure and dynamics of lipid membranes [1-2]. However, pure model membranes are too simple to represent a complex cell membrane. Hence, it is necessary to study a model membrane system mimicking the composition of a cell membrane. Here, we have prepared brain lipid (BLs) unilamellar vesicles (BLs-ULVs), extracted from the porcine brain tissues, physiologically a relevant model membrane system. We have studied the impact of NSAIDs aspirin (Asp), diclofenac (Diclo), and ibuprofen (Ibu), at varying concentrations on the dynamics of BLs using quasielasitc neutron scattering (QENS) and neutron spin echo (NSE). Normalized QENS spectra show that Asp, Diclo, and Ibu induce the highest QE broadening at 30, 10, and 20 mol%, respectively. QENS spectra are described by two Lorentzian corresponding to slow lateral and fast internal motion. The half width half maxima corresponding to lateral, Γ_{lat}, and internal, Γ_{int}, motions show unique behavior for each NSAID. The lateral motion follows Fickian diffusion and the internal motion is described by localized translational diffusion [3]. NSE spectra are described by Zilman and Granek model [5]. Modulus of bending rigidity (κ_{kBT}) BLs-ULVs rises in the presence of Asp. Whereas, κ_{kBT} of BLs-ULVs decreases at 30 mol% Diclo and increases at 20 mol% Ibu. This suggests that Asp hinders, at all concentrations, and Diclo promotes the membrane fluctuations at 30 mol%. Ibu suppresses the membrane fluctuations only at 20 mol%. This study shows that NSAIDs affect short and long range dynamics uniquely at different concentrations.

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