Atomistic simulation study of adsorption of Vitamin E into DMPC lipid bilayers: Implication for their antioxidant inhibition

Brian Novak, Jieqiong Lin, and Dorel Moldovan

Department of Mechanical Engineering, Louisiana State University, Baton Rouge, LA 70803

Abstract

Vitamin E is a lipid-soluble antioxidant located in cell membranes and function as a free radical scavenger to prevent lipid peroxidation. Understanding the positioning of vitamin E in lipid bilayers can provide valuable insight into the mechanism of lipid-peroxidation inhibition at the molecular level. In this work, using molecular dynamics (MD) simulations, we determine the potential of mean force (PMF), the location, and the orientation of α-tocopherol (the most biologically active of the eight compounds of vitamin E) inside a DMPC lipid bilayer. The PMF calculations show that α-tocopherol has a very strong affinity for the interior of lipid bilayers. Specifically, the free energy required for moving the α-tocopherol molecule from inside a lipid bilayer into the aqueous environment is about 25 times the thermal energy, value which indicates that α-tocopherol spontaneously leaving a membrane is an extremely rare occurrence. Moreover, the MD simulations demonstrate that α-tocopherol is incorporated in DMPC lipid bilayers and is concentrated in a relatively narrow region, just below the membrane/water interface. This is of great significance because even if their concentration in food is relatively low, the spatial confinement of α-tocopherol inside membranes greatly enhance their concentration in this vital region, thus increasing their importance for in vivo biological activities including oxidative stress defense.

.

*Work supported in part by the NSF-EPSCoR, LA-SiGMA Grant # EPS-1003897. Computer resources were provided by LONI and by HPC@LSU.