Thermodynamic Properties of Calcium-Containing DPPA and DPPC Liposomes

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Abstract : The work is about the preparation of calcium-containing 1,2-Dipalmitoyl-sn-glycero-3-phosphocholine (DPPC) and 1,2-Dipalmitoyl-sn-glycero-3-phosphatidic acid (DPPA) and their calorimetric study. In order to prepare these complex liposomes, for the first stage it is necessary for ligands and lipids to directly interact, followed by the addition of pH-buffered water or solvent at temperatures slightly above the liposome phase transition temperature. The resulting mixture is briefly but vigorously shaken and then transformed into liposomes of the desired size using an extruder. Particle sizing and calorimetry were used to evaluate liposome formation. We determined the possible structure of calcium-containing liposomes made by our new technology and determined their thermostability. The paper provides calculations showing how many phospholipid molecules are required to make a 200 nm diameter liposome. Calculations showed that $33x10^3$ lipid molecules are needed to prepare one DPPA and DPPC liposome. Based on the calorimetric experiments, we determined that the structure of uncomplexed DPPA liposomes is unilaminar (one double layer), while DPPC liposome is a nanoparticle with a multilaminar (multilayer) structure. This was determined by the cooperativity of the heat absorption peak. Calorimetric studies of calcium liposomes made by our technology showed that calcium ions are placed in the multilaminar structure of the DPPC liposome. Calcium ions also formed a complex in the DPPA liposome structure, moreover, calcium made the DPPA liposome multilaminar, since the cooperative narrow heat absorption peak was transformed into a three-peak heat absorption peak. Since both types of liposomes in complex with calcium ions present a multilaminar structure, where the number of lipid heads in one particle is large, the number of calcium ions in one particle will also be increased. That makes it possible to use these nanoparticles as transporters of a large amount of calcium ions in a living organism.

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