nanoparticles with diameters of around 12 nm, that is, NLC (nanostructured lipid carriers), NE (nanoemulsion), and SLN (solid lipid NPs) to recognize lipids organizations in the carriers [118]. These lipid nanoparticles contained oleic acid and stearic acid lipids plus sodium dodecyl sulfate surfactant dispersed in water (Fig. 19). Additionally, the influence of solid/liquid ratio on distribution of NLC lipids in the carriers was examined. At equilibrium, it was found that vesicle-like structures were formed in all carriers in which the hydrophilic fragments of surfactant and lipids were arranged as a semi-bilayer that was folded to a droplet with their hydrophobic tails were accumulated amongst them. Though it was expected that the harsh sodium dodecyl sulfate surfactant was located on the droplet surface, it was entered the lipids. Furthermore, high amount of water beads were entrapped within the droplets as one or more cavities alongside the inner layers of head groups that were enclosed with the head groups of lipids. Also, for the SLN and nanoemulsion structures, in the droplets centers, denser lipids were formed compared with that of the NLC. Additionally, crystallization did not take place in the lipid carriers. The lipid distribution in the NLC carrier was not affected by the solid/liquid lipid mass ratio.

10. LIPOSOMES AS DRUG DELIVERY SYSTEMS

Liposome drug carriers exhibit valuable advantages like nontoxicity and biodegradability that are generally formed from amphiphatic phospholipid compounds [119]. So far, important advances have been attained on using liposome drug delivery formulations but there are little approved liposome drugs for clinical usage and primarily as antitumor and antifungal agents. Indeed, the clinical applications of liposomal DDSs especially include cancer chemotherapy and acute fungal toxicities [120]. The anticancer drugs encapsulated in liposomes illustrate highly different pharmacokinetics and biodistributions which cause decreased cytotoxicity and enhanced targeted drug release into anticipated tissues. Liposomes have spherical and enclosed shapes that create lipid bilayers or membranes. Phospholipids reveal asymmetric structures containing hydrophobic chains of fatty acids and hydrophilic choline and phosphate head groups. Hence, the structural and physicochemical characteristics of liposomal bilayers are not isotropic.

In fact, liposomes form single membranes known as unilamellar liposomes that are large or small unilamellar vesicles or they form multilamellar membranes representing matryoshka doll shaped concentric structures called multilamellar vesicles [121]. In multilamellar liposomes, the number of concentric membranes indicates the liposome lamellarity. The liposome DDSs are exceptionally miscellaneous. They are able to transport hydrophobic cargos in the lipid nonpolar core of their membranes or hydrophilic cargos within their inner aqueous pocket. Moreover, the head groups of phospholipids can be conjugated with polymers to protect them. Furthermore the lipids functionalized by polymers can be conjugated with targeting ligands for application in targeted drug carriage [122].

Sheared polymers grafted to flat surfaces were created in the MD simulations as liposomes functionalized by PEG brushes that could be used as drug carriers for the topical therapy of human vasculature diseases [123]. In such application, particular rheological features must be met like low viscosities at large shear rates to enhance the liposomal drug carriage. Consequently, MD simulations were done on polymeric PEG brushes with different lengths and shear rates were applied to achieve average viscosities and friction coefficients that were affected by polymerization degrees and shear rates in theta solvents. It was exhibited that high shear rates led to substantial shear thinning of the PEG brushes. The simulation data were in agreement with the measured viscosity values at high shear rates for red blood cells within a solution containing liposomes.

Flavonoids and cathechins display various advantageous that help to be healthy. They contain two substances that exhibit, among others, therapeutic and antioxidant properties. These compounds include morelloflavone (MF) and epigallocatechin 3-gallate (EGCG) extracted from Garcinia dulcis and green tea, respectively. MD simulations were carried out to study the interactions of MF and EGCG by the lipid bilayers indicating addition of salts affected the encapsulation degree of the neutral liposomes [124]. As expected, EGCGs were bound onto the hydrophilic phospholipids groups to be mainly placed at the lipid-water interface. The salt concentration and formula influenced absorption of the EGCG. Moreover, aggregated MFs were highly stable in water that greatly penalized the interactions of flavonoid by the polar lipid head groups. The MF penetration into the liposome was affected to the salts presence although they are cannot entirely assist its absorption into the bilayer. The penetrations of both substances were increased on adding magnesium chloride but calcium chloride indicated a reverse influence.

Liposomal drug carriers are used to be adhered onto specific tissues and sites. Nevertheless, information is little about precise drug delivery mechanisms and drug