Effective Biodegradable Amphiphilic Polycaprolactone Micelles for Drug Delivery Applications

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Abstract: The systematic drug delivery of the anticancer drug is one of the significant challenges in cancer treatment. The polymeric micelles obtained from biodegradable amphiphilic aliphatic polyesters have emerged as a promising candidate in recent years. However, the low drug loading capacity, premature drug release, and poor thermodynamic stability are still the concerns around their clinical applications. Traditionally, experimental designs are utilized to prepare and screen the suitability of a micellar carrier as a drug delivery carrier, which is cumbersome and time-consuming. Herein, we employed all-atom molecular dynamics simulations to design efficient drug delivery carriers. Four polymeric micelles with poly(ε-caprolactone) with distinct cyclic, aromatic, and heteroaromatic pendant groups at the γ–position were chosen as a hydrophobic block. At the same time, poly(ethylene glycol) was selected as a hydrophilic block. The best performing micelles in MD simulations were synthesized, and we determined their critical micellar concentration, drug loading capacity and morphology. The micelles were found to have higher drug loading capacity and found to have spherical morphology. The *in vitro* drug release shows that the micelles show accelerated drug release in acidic pH. The cell viability and cellular uptake studies show that the micelles are biocompatible and readily embedded in the cells. Our approach uses computational methods to screen novel polymeric materials for drug delivery applications.