Eugenol Conjugation to PHEMA and PDMAPMA-b-PHEMA Enabling Nanoparticle Self-Assembly

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Amphiphilic polymers are promising platforms for nanoscale drug delivery due to their ability to self-assemble in aqueous media and encapsulate hydrophobic molecules. In this work, eugenol (4-allyl-2-methoxyphenol), a naturally derived compound with antioxidant, antimicrobial, and anti-inflammatory properties [1], was conjugated to polymers synthesized via RAFT polymerization [2], namely poly(2-hydroxyethyl methacrylate) (PHEMA) and the cationic block copolymer PDMAPMA $_{116}$ -b-PHEMA $_{76}$. The functionalization was designed to impart intrinsic bioactivity and modulate amphiphilicity, promoting self-assembly in aqueous solution. The resulting nanostructures were used to encapsulate Coumarin-6 as a model hydrophobic compound [3] during the self-assembly process. The presence of the cationic PDMAPMA block significantly affected both encapsulation and antioxidant properties. In particular, the cationic copolymer showed lower encapsulation efficiency, likely due to the solvated charged groups promoting a more extended conformation and limiting the formation of compact hydrophobic domains. Conversely, this structure enhances the accessibility of eugenol moieties to DPPH radicals, resulting in higher antioxidant activity compared to PHEMA. Overall, this approach enables the development of multifunctional nanoplatforms with self-assembly capability, colloidal stability, and intrinsic bioactivity for potential biomedical applications.

Keywords:
amphiphilic polymers; nanoparticles; eugenol; drug delivery; self-assembly

References:

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