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Comparative study on the interactions of cationic gemini and single-chain surfactant micelles with curcumin

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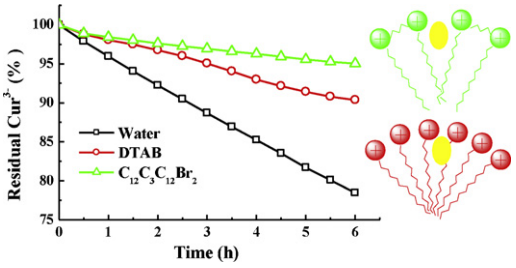
HIGHLIGHTS

- Stability of trianionic curcumin can be improved by cationic surfactant micelles.
- Trianionic curcumin is located in micelle palisade layer by electrostatic attraction.
- Gemini surfactant micelle leads to more remarkable changes in curcumin's spectra.
- Structure and aggregation of surfactant molecules have an important role.

GRAPHICAL ABSTRACT



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ABSTRACT

The interactions of curcumin with cationic micelles of gemini surfactant trimethylene-1,3-bis-(dodecyldimethyl ammonium bromide) ($C_{12}C_3C_{12}Br_2$) and single-chain surfactant dodecyltrimethylammonium bromide (DTAB) were investigated. At pH 13, the trianionic curcumin (Cur^{3-}) had rapid degradation to about 21.5% with an observed rate constant (k_{obs}) of 0.0402 h^{-1} in water, whereas DTAB micelle and $C_{12}C_3C_{12}Br_2$ micelle can suppress Cur^{3-} degradation to 9.6% with k_{obs} = 0.0174 h^{-1} and to 5.0% with k_{obs} = 0.00782 h^{-1}, respectively. Cur^{3-} also showed higher intensities of characteristic peaks with the position changes in absorption and fluorescence spectra as well as increased anisotropy (r) in two surfactant micelles than in water. These results were ascribed to the solubilization of Cur^{3-} in the palisade layer of DTAB and $C_{12}C_3C_{12}Br_2$ micelles through the attractive electrostatic interactions between negatively charged groups of Cur^{3-} and quaternary ammonium headgroups of surfactants, which was also supported by the values of lowest pK_a (pK_{a1}) and corresponding thermodynamic parameters of curcumin in water, DTAB and $C_{12}C_3C_{12}Br_2$ micelles. The stronger electrostatic attractions between Cur^{3-} and the micelle of $C_{12}C_3C_{12}Br_2$ brought about more increased stability of Cur^{3-} and more remarkable changes in absorption and fluorescence spectra of Cur^{3-} in $C_{12}C_3C_{12}Br_2$ micelle than in DTAB micelle.

1. Introduction

The knowledge of the mechanism of interaction between surfactant micelles and drugs has important values for the design of drug formulations and delivery systems, because surfactant micelles are widely used in drug industry in order to enhance drug aqueous solubility, maintain drug stability, control drug release and uptake, and improve bioavailability of drugs [1–3].

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