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Spectrophotometric study of quercetin in metallomicellar solutions of 1-hexadecyl-4-aza-1-azoniabicyclo[2.2.2]octane bromide complex with copper dibromide

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ABSTRACT

The influence of 1-hexadecyl-4-aza-1-azoniabicyclo[2.2.2]octane bromide (D-16) complex with copper dibromide ([D-16 × $CuBr_2$]) on the solubility of quercetin has been investigated by spectrophotometric method. High solubilization activity of the system in both premicellar and post-critical micelle concentration (CMC) ranges of complex concentrations was found. Analysis of spectral data strongly supports the interaction of metallosurfactant with quercetin and testifies the partial modification of the drug, including the complexation of quercetin with a copper cation below and above the CMC and the oxidation of the drug in micellar solutions. Solubilization of the drug in [D-16 × $CuBr_2$] micelles is accompanied by changes in size behavior of aggregates of the complex.

1. Introduction

Supramolecular systems based on surface-active agents (surfactants) are considered as biomimetic systems and attract research interest in the fields of chemistry, biology and pharmacy. They are widely used to fabricate new materials, to solve environmental problems, to develop green chemistry technologies, etc. Inclusion of transition metal into amphiphilic molecules may considerably modify their functional activity [1], which is of particular importance in biomedical applications [2–4]. Meanwhile before supramolecular systems may be approved for practical applications they need to be comprehensively characterized in terms of physico-chemical parameters. This would provide fundamental basis for the further examination of their practical potential in modern technologies. In our studies a variety of surfactants has been explored, with special attention paid to homological series of cationic amphiphiles [5–8]. For these series, aggregation properties, solubilization capacity, complexation with DNA, catalytic and antimicrobial effects were examined. Data obtained are of importance from the viewpoints of information resource for the comparison of key characteristics responsible for the functional activity. Besides, they provide rational for choosing the composition of formulations for the solution of practical tasks.

Mono- and dicationic surfactants, derivatives of 1,4-diazabicyclo[2.2.2]octane (DABCO) are reported to show aggregation activity similar to typical cationic surfactants with trimethyl ammonium (TMA) head groups [9–12], in particular, critical micelle concentration (CMC) of hexadecyl homologues DABCO (D-16) (Scheme 1) and cetyl trimethyl ammonium bromide (CTAB) are identical [9]. Meanwhile DABCO based surfactants are characterized by essential benefits from the viewpoint of potential technological applications over TMA series due to (i) diverse morphological behavior, which can be developed toward superamphiphilic performance by combination with calixarene platform [13,14]; (ii) higher solubilization capacity [15,16]; (iii) high catalytic effect, which can be modified by noncovalent conjugation with the calixarene or polymer matrixes [17–20]; (iv) marked antimicrobial activity [10]; (v) lower toxicity, which can be further diminished by addition of nontoxic hydrotropic additives [21]; (vi) presence of electronic donor center capable of complexing with metal ions, thereby enhancing aggregation and functional activity of DABCO surfactants [22, 23]. We are aware that dynamic systems like micelles are strictly limited for in vivo application. Meanwhile micelles loaded with drugs and probes can be used as a matrix for the further fabrication of more stable nanocontainers and capsules [24].

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