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ORIGINAL ARTICLE

Ratiometric Interactions of Anionic Surfactants with Calf Thymus DNA Bound Cationic Surfactants: Study II

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Abstract Cationic surfactant cetyltrimethylammonium bromide (CTAB) and cetylpyridinium bromide (CPB) bind to the calf thymus DNA (ct-DNA) like anionic biopolymers electrostatically, and establish equilibrium in aqueous medium at pH 7. At low concentration, ct-DNA does not interact with anionic surfactants, sodium dodecylsulfate (SDS) and sodium dodecylbenzylsulfonate (SDBS). However, in the ground state, anionic surfactant is found to clearly establish equilibrium with ct-DNA-bound cationic surfactant whereby the same surfactant–DNA isosbestic point reappears. We herein report a detail ratiometric binding of CPB with ct-DNA, and interaction of anionic SDBS with DNA-bound CPB in comparison with the combined ct-DNA–CTAB–SDS system. Compaction of ct-DNA in presence of CPB and its decompaction using anionic SDBS is also studied in comparison with CTAB–SDS combination. The techniques used are tensiometry, spectrophotometry, viscometry, cyclic voltammetry, circular dichroism, isothermal titration calorimetry, and density functional theory (DFT)-based computational calculations. The size and surface charge density of the surfactant headgroups and the phosphate group in DNA have a contributing role in the DNA compaction–decompaction phenomenon.

Keywords DNA compaction–decompaction · Cationic and anionic surfactant combination · CPB–SDBS · CTAB–SDS · Electrostatic interaction

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Introduction

Compaction of elongated DNA on interaction with cationic surfactant/lipid, and its subsequent decompaction and release is well known (Bhattacharya & Mandal, 1997; Chatterjee, Moulik, Majhi, & Sanyal, 2002; Cuomo et al., 2013; Maulik, Dutta, Chattoraj, & Moulik, 1998; Pulido, Aicart, & Junquera, 2009; Ran, Wang, Yang, & Zhang, 2011; Yua, Dingc, Gaod, Zhengc, & Chena, 2008) for their biological relevance and potential biotechnological applications, including DNA purification (Geck & Nasz, 1983; McLoughlin, O'Brien, McManus, Gorelov, & Dawson, 2000) and gene delivery (Huang, Hungand, & Wagner, 1999; Lasic, 1997). The compaction with the reduction of charges is believed to aid the uptake of biopolymer through the cellular membrane. Once inside, the compacted DNA must be protected from nuclease enzymes to allow it to reach the nucleus. Cationic surfactants are well known for this provision (Bhattacharya & Mandal, 1997; Chatterjee et al., 2002; Cuomo et al., 2013; Geck & Nasz, 1983; Huang, Hungand, & Wagner, 1999; Lasic, 1997; Maulik et al., 1998; McLoughlin et al., 2000; Pulido et al., 2009; Ran et al., 2011; Yua et al., 2008). It may be added that DNA–cationic surfactant interactions have differences for double-stranded DNA (dsDNA) and single-stranded DNA (ssDNA; Rosa, Dias, da Graça, & Lindman, 2005). *In vivo* compaction dynamics of bacterial DNA with reference to understanding

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