

Comparative Study of Hydroxypropyl cellulose and Bovine Serum Albumin

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ABSTRACT

In this work we compare the similarities and differences between Polymer like Hydroxypropylcellulose (HPC) with that of of Bovine Serum Albumin (BSA) protein with surfactants. Tensiometric study was considered for their comparison. The tensiometric profiles of surfactants in the presence of HPC and BSA exhibit two breaks, one is at critical aggregation concentration (CAC) corresponding to onset of interaction of surfactants with HPC or BSA and the second at C_1 corresponding to saturation of the interface. The study will help us to carry extensive study of proteins by using synthetic polymers which are less sensitive than proteins. The study may be also helpful to understand nature of interaction between proteins and surfactant by considering interactions of synthetic polymers where problem of denaturation is meaningless. The study can also help in knowing membrane structure.

I. INTRODUCTION

Polymer- Surfactant interactions [1,2] have become increasingly important due to their complex fundamental nature and enormous industrial applications. In spite a lot of work that has been devoted to this field, the complex nature of such interactions is still under research. In the case of charged polymers, it is comparatively easier to understand the electrostatic interactions between the oppositely charged polymer and ionic surfactants, however the situation is quite intriguing and complex in case of neutral polymers. In case of neutral polymer, the surfactant-polymer interactions depends upon several factors such as nature of surfactant head group, the nature of the polar groups embedded in the polymer backbone, and polymer hydrophobicity [1]. The binding of charged surfactant micelles to a flexible/semi-flexible non-ionic polymer has been demonstrated to cause characteristic changes in the hydrodynamic properties of the polymer solution, as confirmed by dynamic light scattering analysis [3]. In such systems, indeed the interaction between surfactants and polymers results from hydrophobic interactions between surfactant tails and hydrophobic moieties of neutral polymer and from hydrogen bonding between surfactants head groups and hydrophilic portions of polymer. Therefore, it can be said that the hydrophilic-lipophilic balance between surfactant and polymer moieties play a governing role in such interactions. Recently, it is observed that the mixed cationic micelles have significant interactions with neutral polymers [4-6], which change by the variation in the mole fractions of the binary mixture.

II.MATERIALS AND METHOD

The amphiphiles used during the experimental study were cetyltrimethylammonium bromide (CTAB) and polyoxyethylene (10) cetyl ether (Brij-56). The CTAB was received from sigma while as Brij56 was received from Fluka. The polymer used was hydroxypropylcellulose (HPC) and was obtained from Aldrich. All products were used as received. Stock solutions of Brij56 and CTAB were prepared at concentrations of 15mM and 25mM respectively. stock solution of 0.5% was prepared for hydroxypropylcellulose. The stock solutions were utilized to prepare the samples of various concentrations needed for the experimental work. All solutions were prepared in triple distilled water and polymer solutions were prepared in weight by volume percentage.

III.DETERMINATION OF CMC AND CAC

The CMC and CAC values of surfactant solution were determined from the plot of surface tension (γ) vs. logarithm of surfactant concentration ($\log C_t$) as shown in Figures 3.1, and 3.2. Surface tension measurements were made by the ring detachment method using a Kruss-9 (Germany) tensiometer equipped with a thermostable vessel holder that holds the vessel containing the experimental solution. The experiment was carried at constant temperature.

30 ml water or polymer solution were placed in the sample vessel and constant temperature water from the thermostatic bath circulated into the vessel holder for 30 minutes to allow the sample to acquire the set temperature. Measurements were made after thorough mixing and temperature equilibration at 25 °C ($\pm 0.1^\circ\text{C}$) by circulating water from a thermostat through the vessel holder. The accuracy of measurements was within 0.1 dyne cm^{-1} .

3.1 HPC with Brij56 and CTAB

Fig 3.1 shows the variation of surface tension of the two surfactant solutions with surfactant concentration in presence of polymer (HPC) when single surfactants were considered. Two break points are prominent in these tensiometric plots. The lower concentration break corresponds to critical aggregation concentration (CAC) while the higher concentration break marks the beginning of polymer free Micellization. Up to CAC, γ remains more or less constant signifying that Brij56 or CTAB cannot interact with the HPC adsorbed at the air/solution interface. Therefore, CAC signifies the onset of interaction/ displacement at the air/solution interface. Above the CAC, γ decreases until the interface is saturated or the displacement process is complete to yield C_1 . Decrease in γ can either be due to specific binding of Brij56 or CTAB with HPC, thereby increasing its hydrophobicity or competitive adsorption between the HPC and Brij56 or CTAB. Constancy in γ up to the CAC suggests the absence of specific interactions between Brij56 or CTAB and HPC.

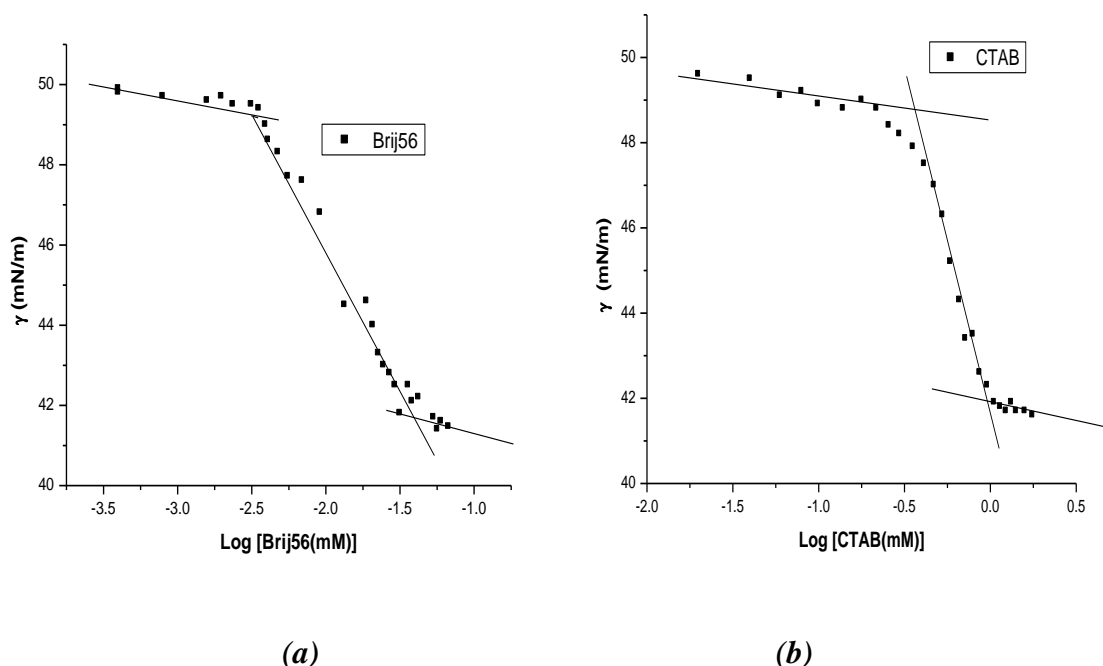


Figure 3.1: Plot between surface tension vs logarithm of: (a) Brij56; (b) CTAB concentration in presence of 0.01% HPC.

Further competitive adsorption not only depends on the nature of the surfactant, but also on the concentration of the surfactant in the bulk [7]. This is because at low concentrations, the surface activity of Brij56 and CTAB is lower than the surface activity of HPC, but above the CAC their surface activity becomes higher than that of the polymer (Fig 3.1) and hence are preferentially adsorbed at the interface. Below the CAC, HPC restrains the adsorption of Brij56 and CTAB on the interface. It is found that the binding of charged surfactant micelles to a flexible/semi-flexible non-ionic polymer has been demonstrated to cause characteristic changes in the hydrodynamic properties of the polymer solution. The surfactant-polymer complex may be more surface active than the surfactant alone.

Table 3.1:- CAC and CMC of Brij56 in Presence of HPC.

S. No.	Polymer concentration	Surfactant	CAC (mM)	CMC (mM)
1	0.01%	Brij56	0.003	0.040
		CTAB	0.365	0.957

When the behaviour of above surfactants in presence of HPC is compared with the behaviour of Bovine Serum Albumin with surfactants mentioned, as reported in the paper “Interaction of Bovine Serum Albumin with Cationic Single Chain +Nonionic and Cationic Gemini+Nonionic Binary Surfactant Mixtures” [7], then it is found that behaviour of surfactants is same in presence of protein (Bovine Serum Albumin) or Polymer (hydroxypropylcellulose). This comparison shows that like hydroxypropylcellulose, Bovine Serum Albumin is also hydrophobic in nature. it is necessary to mention here that similarity in the behaviour of HPC and BSA with surfactants was observed when BSA was 3 μ M. Further, interaction pattern of surfactants is same in presence of HPC or BSA i.e, in both case we get parameters like CAC and CMC for the surfactants [7]. It seems that interaction of BSA with cationic surfactants is much less than its interaction with non ionic surfactants.

Moreover, it is found that HPC and BSA shows more similarity with non-ionic surfactants than with cationic surfactants. Thus to understand behaviour of proteins with surfactants we can use polymer-surfactant behaviour, because unlike proteins external factors like temperature, pH, nature of medium etc. does not effect the behaviour of polymers like HPC.

IV. CONCLUSIONS

HPC and BSA shows similar behaviour with surfactants. Infact this similar behaviour of HPC and BSA is more with non-ionic surfactants.

Unlike BSA, HPC shows appreciable interactions with both cationic as well as non-ionic surfactants.

Interaction of HPC with surfactants can be used to understand protein-surfactant interactions.

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