SURFACTANT BEHAVIOR OF TWO NOVEL GLYCOSIDES: DETERMINATION OF CRITICAL MICELLE CONCENTRATION BY UV-VISIBLE SPECTROPHOTOMETRY

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Introduction

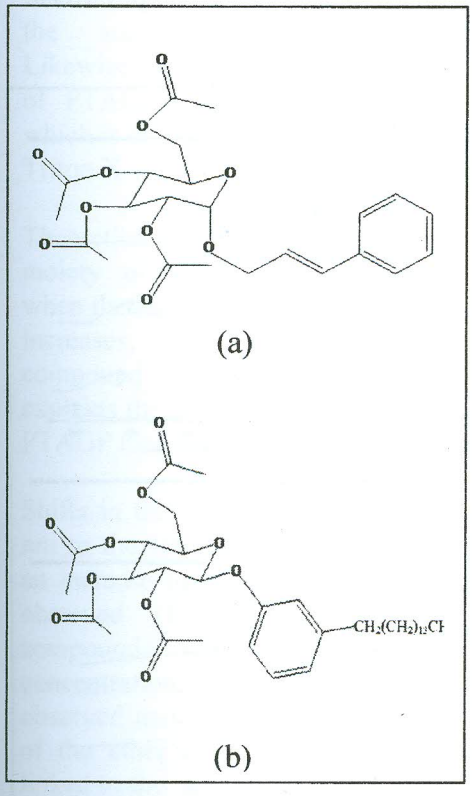

Figure 1. Structural formula of a) Cinnamyl 2, 3, 4, 6-tetra-O-acetyl-α-D-glucopyranoside (CTAGP) b) 2,3,4,6-Tetra-O-acetyl-1-O-p-decylphenyl-β-D-glucopyranoside (PTAGP).

The amphiphilic nature of glycolipids is essential for use as surfactants. The main advantage of using glycolipids is their biocompatibility to nature. There is a thriving interest on studies of surfactants because of their use in industrial processes and as bio surfactants. Surfactants form molecular aggregates (micelles) in aqueous solutions by spontaneous self association above a certain concentration; the critical micelle concentration (CMC). The CMC can be determined using tentiometry, spectrophotometry and conductometry. The typical CMC for nonionic surfactants lies in between 10^{-5} -10^{-4} M. The nonionic surfactants form donor-acceptor complexes with iodine in aqueous medium (Haits *et al.*, 2001). The present work is a detailed study of the spectral behavior of non-ionic surfactants-iodine system of the two novel glycosides (Figure 1) and a comparison with standard surfactants. The determination of the CMC is done using the spectral absorption and the shift in the maximum wavelength (λ_{max}) of iodine (blue shift) upon complexation.

Materials and Methods

The iodine used was analytical grade and resublimed product of B. D. H. Ltd. (England). Spectroscopic studies were done using an ultraviolet (UV) – visible recording spectrophotometer (UV – 160A; Shimadzu, Kyoto, Japan) with a

matched pair of 1 cm path length quartz cells at 298 K. Saturated aqueous iodine solution (2.5 mL each) was added into graduated test tubes followed by the addition of a series of concentrations of the glycoside and by the addition of water, the solutions were made up to a volume of 10 mL. Their absorbance spectra were obtained and absorbances at 286, 346 and 460 nm were measured. Also the absorbance maximum of I_2 in each solution was measured to observe the blue shift.

Results and Discussion

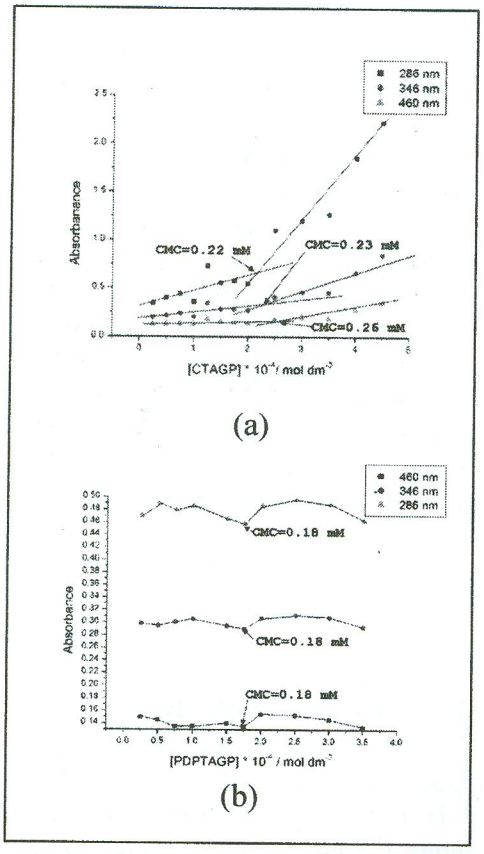

Figure 2. The plot of absorbance vs concentration of a) CTAGP b) PTAGP and I_2 at 286, 346 and 460 nm at 298 K

Two novel glycosides (Figure 1) have been synthesized by direct coupling of glucose with cinnamyl alcohol and 3-pentadecyl phenol, respectively by previous procedures (Abeyrathne *et al.*, 2008). Upon complexation with iodine in aqueous solutions, shifts in the absorbance maximum (λ_{max}) and changes in spectral absorption can be observed.

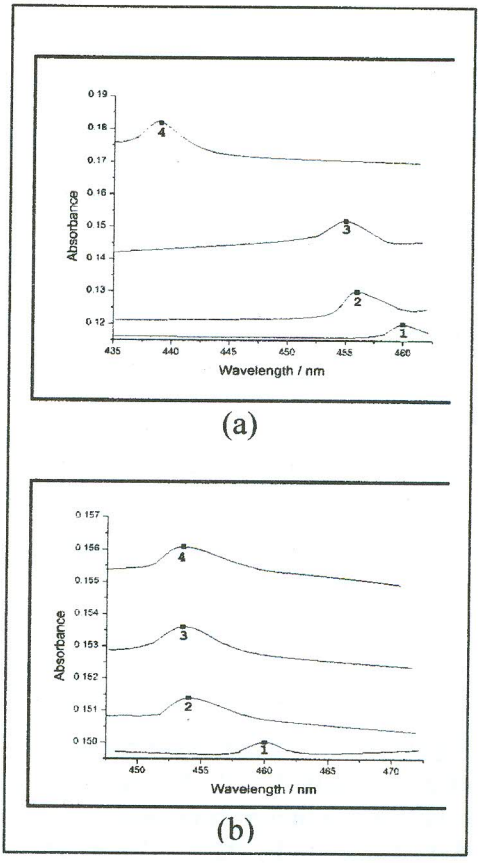

Figure 3. Absorption spectra of a) CTAGP and I_2, Curve 1- I_2; curves 2-4, [CTAGP] × 10^{-4} = 0.5, 1.5 and 2.5 mM respectively b) PTAGP and I_2, Curve 1- I_2; curves 2-4, [PTAGP] × 10^{-4} = 1.0, 1.5 and 2.0 mM respectively at 298 K

For the compound CTAGP, the plot of absorbance at three wavelengths, vs the concentration (Figure 2) shows distinct break points at 0.22 mM, 0.23 mM and 0.26 mM respectively, which is considered as the corresponding CMC values and it is comparable with that of standard non ionic surfactant, Triton X 100 (0.24 mM) which also forms the surfactant-iodine complex. Likewise the observed CMC values of PTAGP are around 0.18 mM which is comparable with that of the Triton X 114 (0.17 mM).

Theoretically, for a fixed polar moiety of a nonionic surfactant, when the length of the nonpolar part increases, the CMC of the compound decreases. Thus this explains the lower value of CMC of PTAGP than that of the CTAGP.

Shifts in the λ_{max} of iodine at 460 nm to the left side (blue shift) and an increase in the absorbance were observed (Figure 3) for both compounds with increasing the concentration. The blue shift, observed may be due to the ability of the ether oxygen in glycosides linked to the anomeric carbon atom to donate electrons to the vacant σ^* orbital in iodine, which leads to the formation of the surfactant-iodine complex. The extent of the shift depends on the structure of the molecule itself.

Conclusion

The CMC values of both CTAGP and PTAGP lies in-between the typical CMC values for nonionic surfactants; 10^{-5} – 10^{-4} M, suggesting that they can be used as nonionic surfactants. However, further theoretical and experimental studies are necessary to be done in future.

Acknowledgements

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References

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