Chapter

7

Overall Conclusion

This chapter describes the overall conclusion of this thesis.

The primary objective of this research work is to explore the association behaviour of surfactants in different solvent systems. Various solvent systems, such as aqueous solvents, polar nonaqueous solvents, or organic solvents, are utilized to study the solution behaviour of surfactants. In the present work, deep eutectic solvents (DESs) were used as a medium for the micellization of surfactants. The clouding phenomenon was also studied in the DES-water mixture. The study also includes the solubilization of curcumin in DES with and without surfactant/salt. For the purpose, various DESs were synthesized and characterized by spectroscopic techniques. Various physicochemical properties of DES were also determined. Every chapter provides unique perspectives and novel approaches to the entire study.

Chapter 1 includes the literature and general introduction about surfactants, phenomena in surfactant solution, various solvent media for micellization, including DESs, classification, properties, and application of DESs, and the association behaviour of surfactants in DES.

Chapter 2 explores the materials, principles, and applications of the characterization techniques used. The techniques discussed encompass Fourier transform infrared spectroscopy (FTIR), Nuclear Magnetic Resonance spectroscopy (NMR), UV-Visible absorption spectroscopy (UV-Vis), rheometer, electrical conductance, pH meter, refractometer, contact angle, tensiometer, spectrofluorometer, and polarizing optical microscopy (POM).

Chapter 3 includes the synthesis of various types of DESs (Type-III, water-based DESs (aquolines), hydrophobic DESs (HDES), and ternary DESs (TDESs)) by heating and stirring the starting components in different molar eutectic ratios. FT-IR and NMR spectroscopy were used for the characterization of synthesized DESs, which confirms the formation of DES. Various physical properties, including zero shear viscosity, relative viscosity, surface tension, contact angle, pH, specific conductance, density, molar volume, Gordon parameter, micropolarity, and apparent dielectric constant of DESs (with and without water), were measured using different techniques. From the rheology data, it has been found that all DESs are Newtonian fluids. Aquolines show a higher contact angle (though less than 900) than water, indicating they are less wettable than pure water. pH, density, and viscosity values decrease with an increase in temperature. Overall, this chapter outlines a systematic approach to synthesizing, characterizing, and evaluating the properties of DESs, offering valuable insights into their potential as alternative solvents and functional materials.

Chapter 4 includes the study of micellization of various surfactants in DESs, reline-water mixtures, and aquolines. The study delves into understanding the intricate interplay between surfactant-solvent interactions and how they influence micellar formation and properties. The micellization of SDS in water in reline and reline in water regions was studied, and it was observed that the presence of water affects the micellar behaviour, leading to changes in critical micelle concentration (CMC). CMC decreases in water in reline region via the formation/breaking of H-bonded structures in ChCl-urea-water motifs. However, CMC decreased in reline in water due to the molecular solution of choline chloride, which furnished a Ch+ counter ion. CMC decreases with increasing water molecules per mole of ChCl in a typical aquoline. Moreover, the influence of salts on micellization behaviour in aquolines is examined, explaining the effect of different salt concentrations and counterions on CMC values and micellar properties. Aquoline polarity and salt-induced micellar morphologies are looked at in this study. It shows how higher-order surfactant aggregates, like vesicles, form in aquoline-salt mixtures. Overall, the chapter provides a comprehensive understanding of surfactant micellization in DESs, highlighting valuable insights into the complex interplay between surfactant-solvent interactions, salt effects, and micellar morphologies. These findings contribute to expanding knowledge of micellar behaviour in non-conventional solvents and pave the way for potential applications in various fields, including materials science and nanochemistry.

Chapter 5 includes the study of the clouding behaviour of SDS (sodium dodecyl sulphate) in the presence of tetra-n-butylammonium bromide (TBAB) in various solvent systems, including reline-water mixture, TDESs. The findings revealed that the addition of TBAB induced clouding in SDS solutions, with the clouding phenomenon influenced by factors such as solvent composition, counterion binding, and micellar architecture. The clouding phenomenon was observed to be dependent on SDS and TBAB concentrations, with higher concentrations favouring clouding. In DES systems, the interaction between TBAB and SDS was influenced by the presence of water and the composition of the DES. Higher DES content and lower water content increased the cloud point (CP) of SDS + TBAB solutions. Additionally, the addition of metal ions such as Zn+2 and Cd+2 affected the CP behavior, with Zn+2 causing a decrease and Cd+2 causing an increase in CP due to their respective interactions with the solvent and micellar surfaces. Overall, the study provides insights into the complex interplay between surfactant-solvent interactions and phase behaviour in SDS + TBAB systems in different solvent environments. The findings contribute to a deeper understanding of clouding phenomena and the design of surfactant-based systems for various applications.

Chapter 6 focuses on investigating the solubilization of curcumin (CCM) in DESs, including reline, glyceline, ternary DESs, and aquolines. The solubilization process is studied using UV-visible and fluorescence spectroscopy. The absorption spectra of CCM in water and DESs showed substantial variations. The solubility of CCM significantly improved in glyceline. Surfactants were found to enhance the solubility of CCM in aquolines, with cationic surfactants demonstrating superior effectiveness compared to anionic surfactants. In aquiline-salt-DES systems, the solubility of CCM increases. Based on the fluorescence data, it was seen that CCM had different levels of fluorescence intensity and emission spectra depending on the solvent conditions and the presence of salts and surfactants. The CCM fluorescence intensity was higher in reline and glyceline than in ternary DESs. This might be because the CCM and DES components interact with each other. The fluorescence intensity of CCM in aquoline-salt-surfactant systems is affected by various parameters, including micellar encapsulation, van der Waals interactions, and the compactness of micelles caused by the addition of salt. The results emphasize the capability of DESs, surfactants, and salts to improve the solubility and fluorescence characteristics of CCM. The adaptability and efficacy of these solvent solutions highlight their usefulness in a range of CCM-related processes, including extraction, formulation, and analysis. Additional investigation into the mechanisms that govern the interactions between CCM and solvents, as well as their effects on solubility and fluorescence qualities, might help to enhance the use of these systems in applications that rely on CCM.