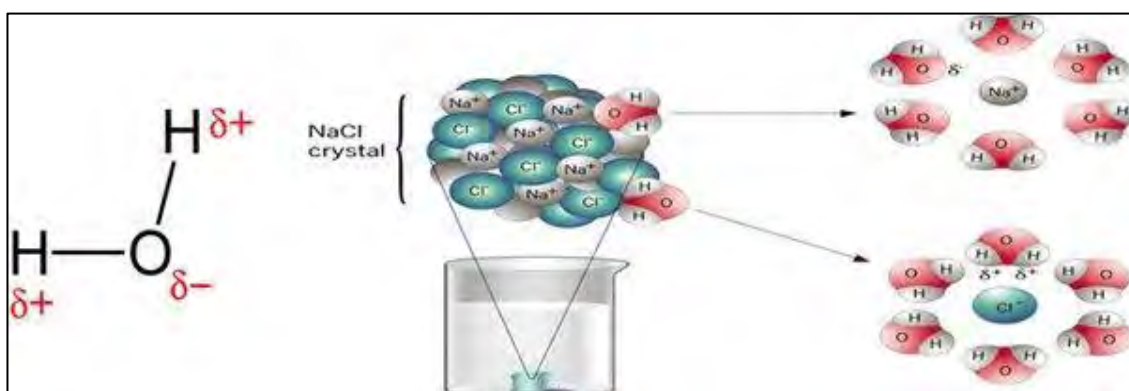


ABSTRACT

The focus of this thesis is to delve deeply into the realm of Supramolecular Host-Guest Inclusion Complexation and the interaction between Food Chemicals and Ionic Liquid along with vitamins with caffeine solution in the solution phase, culminating in molecular synergism that enhances microbial activity. In the field of supramolecular chemistry, biologically potent molecules such as drugs, and bio-active molecules, which are often water-soluble with underdeveloped delivery systems, were selected to form inclusion complexes with cyclodextrins. The objective is to improve solubility and bioavailability. The research employs various physicochemical and spectroscopic methodologies to investigate the mechanisms behind the formation, stability, thermodynamic feasibility, binding ability to albumin protein, and sustained release of drug molecules from inclusion complexes into the surrounding medium.

In the context of solution chemistry, first, the interaction between Food chemicals and Ionic Liquid demonstrates molecular synergism. This aspect holds great importance in food chemistry, considering the substantial global food production and the associated challenges of spoilage.

The investigation of diverse interactions involves measuring apparent molar volume (ϕ_v), limiting apparent molar volume (ϕ_v^0), molar refraction (R_M), and limiting molar refraction (R_M^0). These parameters are obtained through various physicochemical methodologies.

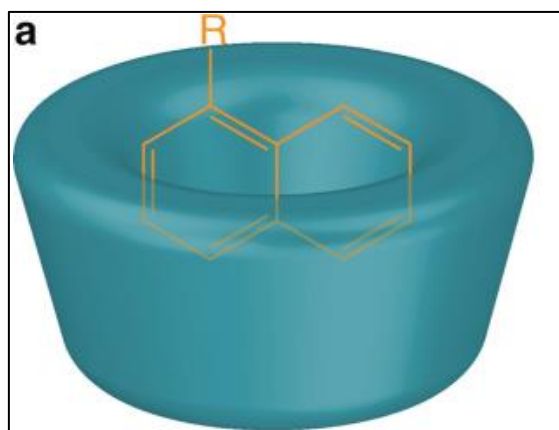


My research in supramolecular chemistry is substantiated by the successful advancement of the following novel aspect:

- (a) Improvement of drug solubility in water to enhance bioavailability

- (b) Controlled drug delivery facility
- (c) Enhancement of antioxidant activity
- (d) Facilitation of cyto-toxicity
- (e) Augmentation of antimicrobial activity

For a drug to exhibit heightened therapeutic effectiveness, achieving substantial bioavailability and solubility is crucial. The pharmacological response necessitates the drug to attain a minimum concentration, underscoring the significance of reaching a desired level of aqueous solubility. A molecule's solubility is qualitatively defined as the spontaneous interaction of two or more substances, resulting in a homogeneous molecular dispersion.



Through experimentation, it was discovered that the formation of drug-cyclodextrins (CDs) inclusion complexes significantly enhances the aqueous solubility of the drug, thereby increasing its bioavailability. This enhancement is attributed to the encapsulation of the hydrophobic segment of the guest molecule within the hydrophobic cavity of appropriately sized CDs. The cavity dimensions of the CDs play a crucial role, as they should be moderate enough to minimize contact between water and the nonpolar regions of both the host and guest molecules. Notably, α and β -cyclodextrins were selected due to the dimensional suitability of their cavity sizes in this context.

Summary of work done

CHAPTER I

This chapter provides a comprehensive exploration of the research work's subject matter, elucidating its scope and applications in modern science.



It delves into the rationale behind selecting bio-active molecules, drugs, vitamins, nerve stimulating chemicals, food food chemicals, ionic liquids, cyclodextrins, and solvent systems for study.

CHAPTER II

This chapter presents a comprehensive review of prior research conducted by scientists and researchers globally in the relevant field. It also provides a detailed theoretical framework for the investigation, elucidating the forces that interact between molecules.



The chapter extensively discusses the theories and applications of various analytical techniques such as ^1H NMR, 2D ROESY, FTIR spectroscopy, UV-Visible spectroscopy, Scanning Electron Microscopy, Powder X-Ray Diffraction, High-Resolution Mass Spectroscopy, computational study, Conductivity, Density, Viscosity, and Refractive Index. It underscores the significance of employing these methods in the research conducted within this thesis.

CHAPTER III

This chapter encompasses the experimental aspects, detailing the nomenclature, structure, physical attributes, purification methods, and applications of biologically active molecules, drugs, vitamins, cyclodextrins, food chemicals, ionic liquids, and solvents employed in the research.

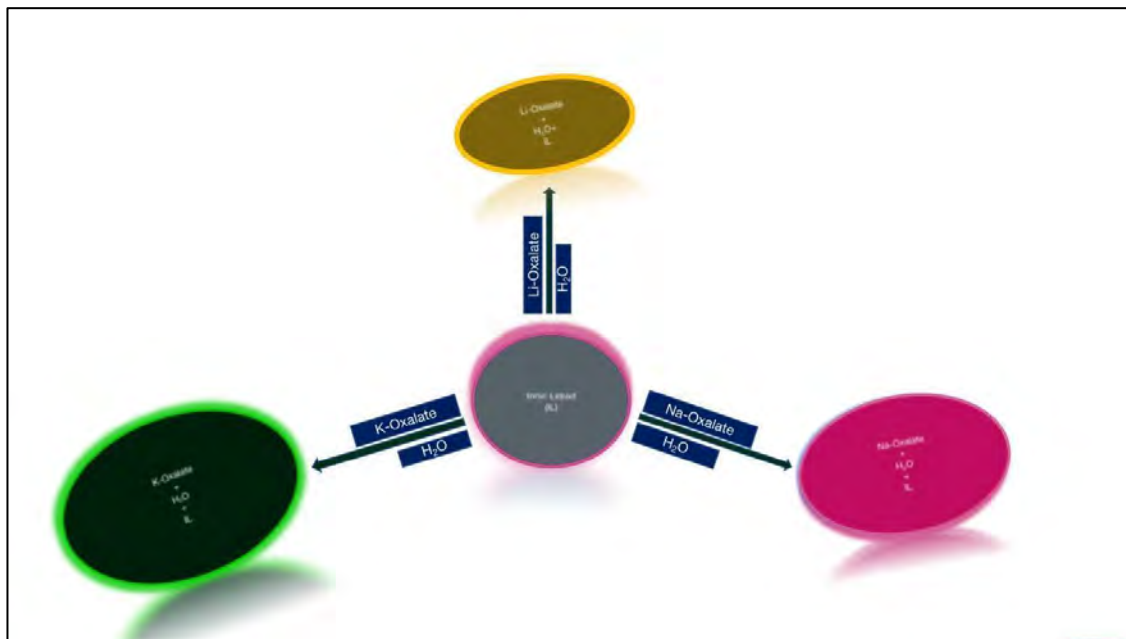


Additionally, it provides comprehensive information on the experimental methods, including descriptions and applications of the instruments utilized in the research.

CHAPTER IV

This chapter includes an investigation on the diverse molecular interactions between implausible food chemicals (potassium oxalate, sodium oxalate and lithium Oxalate) and 1-butyl-1-methyl-pyrrolidinium chloride in aqueous solutions has been presented. The experiments have been discovered thoroughly by different types of physicochemical methodologies like density, refractive index, viscosity, and conductivity at three different temperatures 298.15K, 308.15K and 318.15K. The genesis of diverse interactions of the ternary mixtures were exposed by measurement of

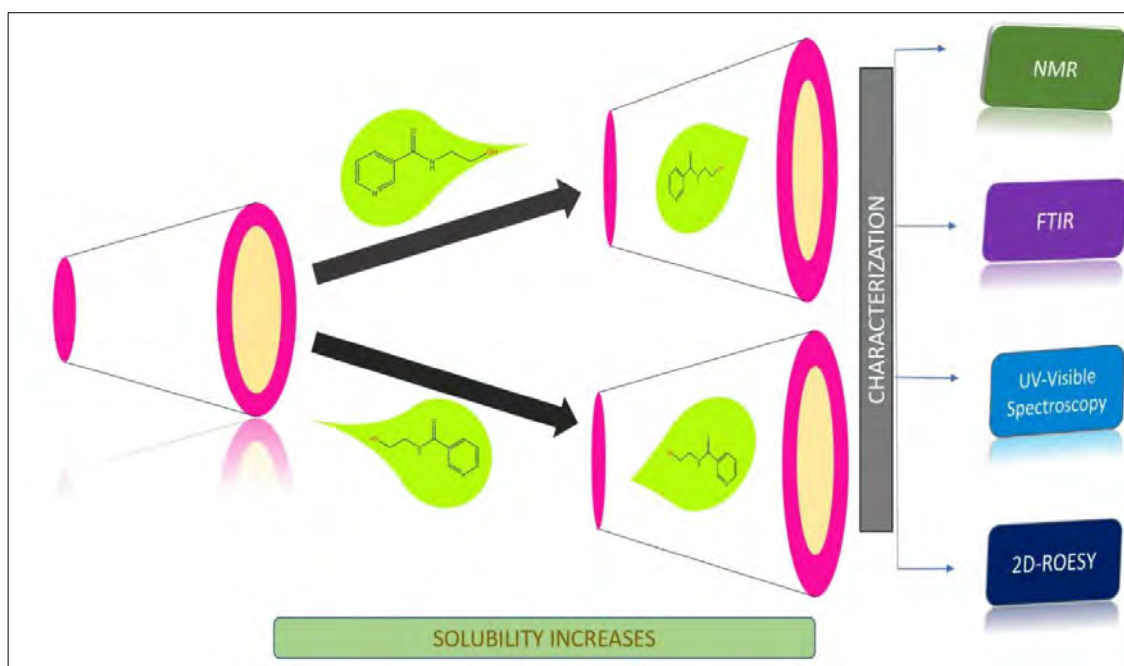
the apparent molar volume (φ_v), limiting apparent molar volume (φ_v^0), viscosity B coefficients, molar refraction (R_M), limiting molar refraction (R_M^0).



The results have revealed the predominant solute-solvent interaction over the solute-solute as well as solvent-solvent interactions. The ionic liquid is more strongly interacting with potassium oxalate than sodium oxalate, which in turn is greater than lithium oxalate at a higher range of temperature. Moreover, Density functional theory calculations were performed to evaluate parameters like adsorption energies, molecular electrostatic potential maps and mode of binding which corroborate the experimental observations.

CHAPTER V

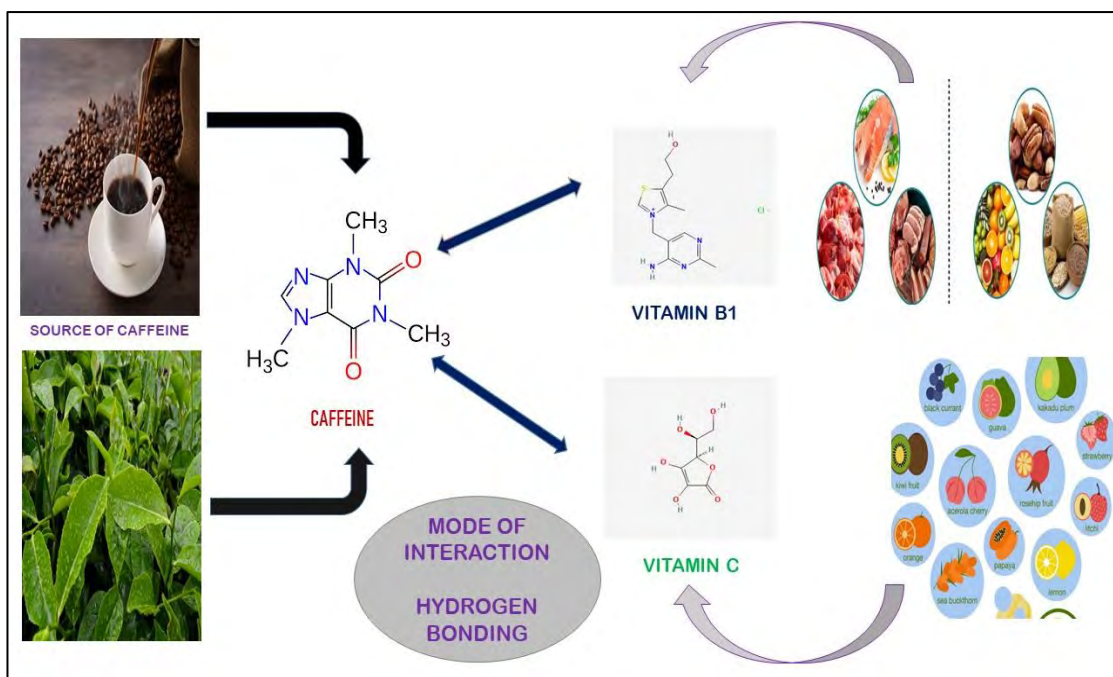
This chapter consists of encapsulation of Nicotinuric acid in the cavity of cyclodextrins. Nicotinuric acid is an agent in the pathogenic mechanism for metabolic syndrome to diabetes and atherosclerotic cardiovascular disease. To protect these external effects (e.g., oxidation, structural modification etc), a systematic study of host-guest complexation of nicotinuric acid with α and β -cyclodextrins has been incorporated. The analysis has been empowered by Spectroscopic study like UV-Vis, FTIR, 2D ROESY NMR, and SEM. Job's plot by UV-vis spectral data shows 1:1 stoichiometric combination of nicotinuric acid and cyclodextrin. The noticeable shifts in FTIR stretching frequency also assisted the inclusion phenomenon.



The reliable magnitude of the association constants (8.27×10^3 & 8.84×10^3 in α -CD and β -CD respectively), obtained from Benesi-hildebrand method, is in good agreement with the stabilities of the inclusion phenomena. In 2D ROESY analysis three off-diagonal peaks are observed due to the intermolecular dipolar cross correlation between the proton of the pyridinium ring of nicotinic acid with the H3 and H5 of α and/or β -CD. Surface morphologies from SEM of the complexes have also been added. Molecular docking has been carried out to explore the fitting mechanism of NUA insight into the cavity of CDs. The guest scores -6.1 kJ/mol and -6.4 kJ/mol with α -CD and β -CD respectively.

CHAPTER VI

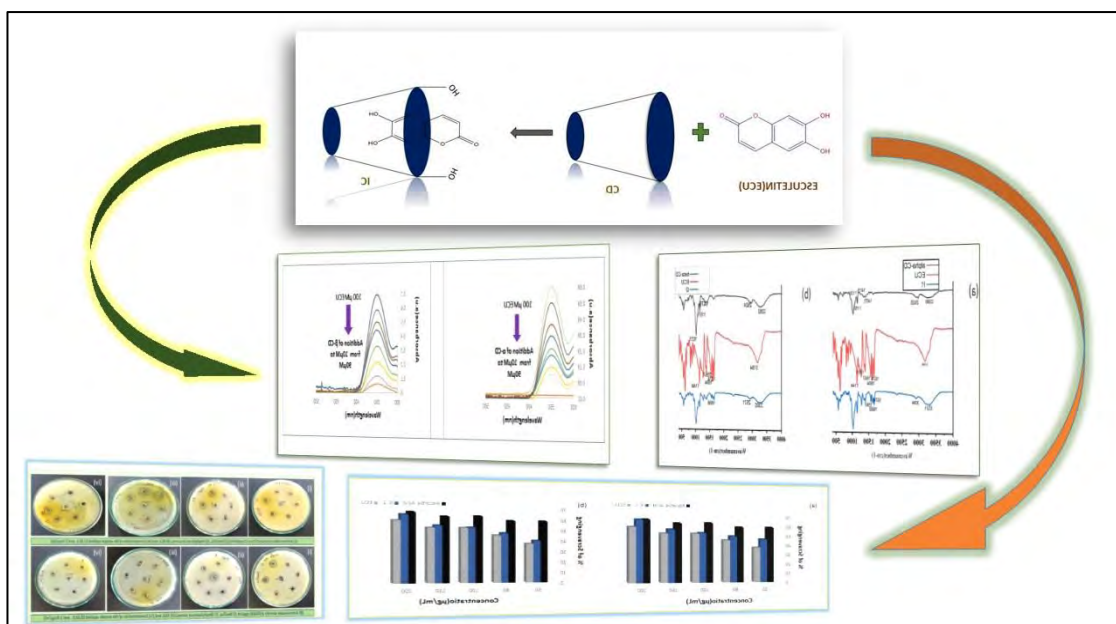
In this paper, Volumetric and viscometric analysis of ascorbic acid and thiamine hydrochloride in caffeine aqueous solution at different mass fractions over the temperature range (298.15K -318.15K) and at 1 atm pressure, have been implemented. All analyses have been interpreted in terms of solute–solute, solvent–solvent and solute-solvent interactions of the considered system. The parameters like apparent molar volume(φ_v) and



limiting apparent molar volume (ϕ_v^0), have been estimated from the density data. Falkenhagen A-coefficients and Viscosity B-coefficients have been predicted from viscosity by implementing the Jones-Dole equation. The Hepler's constant and R_M have been evaluated. DFT calculation predicts the mode of binding which correlates the practical observations. By the help of physicochemical and computational techniques, we found that vitamins behave as structure breaker in caffeine solution.

CHAPTER VII

In this paper, Esculetin and α -cyclodextrin, as well as beta-cyclodextrin host molecules, have been intermixed with the help of the coprecipitation method to form a supramolecular complex to offer physical insights into the formation and stability of the inclusion complex (IC). The characterization of the synthesized product was done by Powder X-ray diffraction (XRD), electrospray ionization mass spectrometry (ESI-MS), ^1H nuclear magnetic resonance (^1H NMR), Fourier transform infrared (FTIR) spectroscopy, electrospray ionization (ESI) mass spectrometry, Scanning Electron Microscopy (SEM).



The stoichiometric ratio of 1:1 is obtained from Job Plot and the Benesi–Hildebrand double reciprocal plot provides the association constant values supported by the ESI mass data. The inclusion complexation is validated by the systematically analyzed results of molecular modeling, additionally, the outcomes achieved from ^1H NMR and FTIR spectroscopy studies which reinforce the complexation phenomenon. The encapsulation of Esculetin into α -cyclodextrin along with beta-cyclodextrin is determined by the results acquired from computations in addition to experimental data.

CHAPTER VIII

This chapter includes the concluding remarks about the research works done in this thesis.

