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Ultrasonic Absorption Studies in aqueous β -Alanine and L-Glutamic Acid (Monosodium salt)

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ABSTRACT

The ultrasonic wave propagation studies providing an understanding of physical and chemical properties leading to the knowledge of structure and properties of matter. The absorption and dispersion of ultrasonic waves provide information about relaxation process in liquids. It is the key to solve the critical problems with the role and interaction of these substances in living organism. The present paper describes the results of ultrasonic velocity and absorption measurements, made employing Pulse Echo Overlap (PEO) technique at 2 MHz at 298K in β -Alanine and L-Glutamic Acid(Monosodium salt) and related parameters relaxation time, classical absorption; excess absorption and volume viscosity has also been evaluated. These studies shows that the nature of molecular interaction and complex formation in solution of biomaterials provide important information regarding molecular properties of solvent and solute interaction.

Key words: Ultrasonic absorption, Relaxation Time, Volume Viscosity, Molecular Interaction,

INTRODUCTION

Ultrasonic absorption studies in a medium provide important tools for evaluation of the structural, physical and chemical properties of medium. The nature of ultrasonic absorption properties of aqueous protein solution shed more light on many chemical analyses as well as an idea about the complexity of protein molecules. The ultrasonic properties of liquid and biological media have been studies in detail by many researchers [1-16].

β -Alanines are hydrophobic and totally nonpolar, which is involved in the metabolism of tryptophan and the vitamin pyridoxine. It is one of the most widely used amino acids in protein construction, averaging about 9 % of average protein composition. Alanine is found in prostate

and may play an important role in prostate health. Sources of alanine are meat, poultry, eggs, dairy products and fish. People suffering from Epstein Barr (glandular fever) as well as chronic fatigue syndrome, have been linked to excessive high levels of alanine.

Glutamic acid (monosodium salt) is a white crystalline powder and soluble in water. Protein rich food such as breast milk, cheese and meat contains large amount of bound glutamate while most vegetables contain relatively low amounts. L-Glutamic acid is highly polar with negatively charged acidic R-group and hydrophilic in nature. It contains a side chain with an extra carboxyl group with a dissociable proton. The additional negative charge accounts for the electrochemical behavior of the proton.

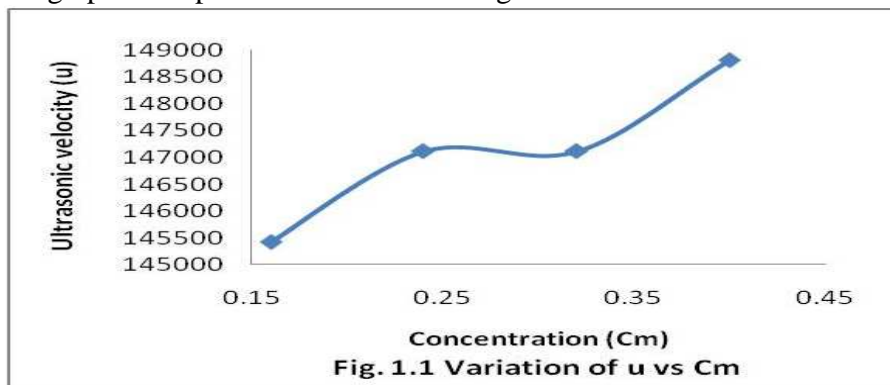
Due to such extensive applications of ultrasound in biomedical technology, in the present study, absorption measurements were undertaken in β -Alanine and L-Glutamic Acid (Monosodium salt) solution at a frequency of 2 MHz and at a temperature of 298 K by pulse echo method.

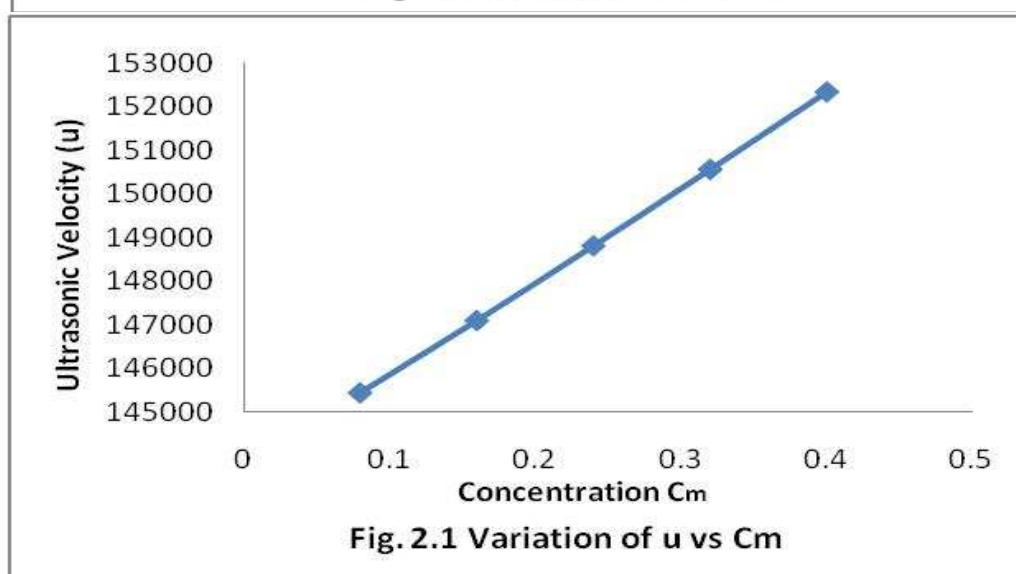
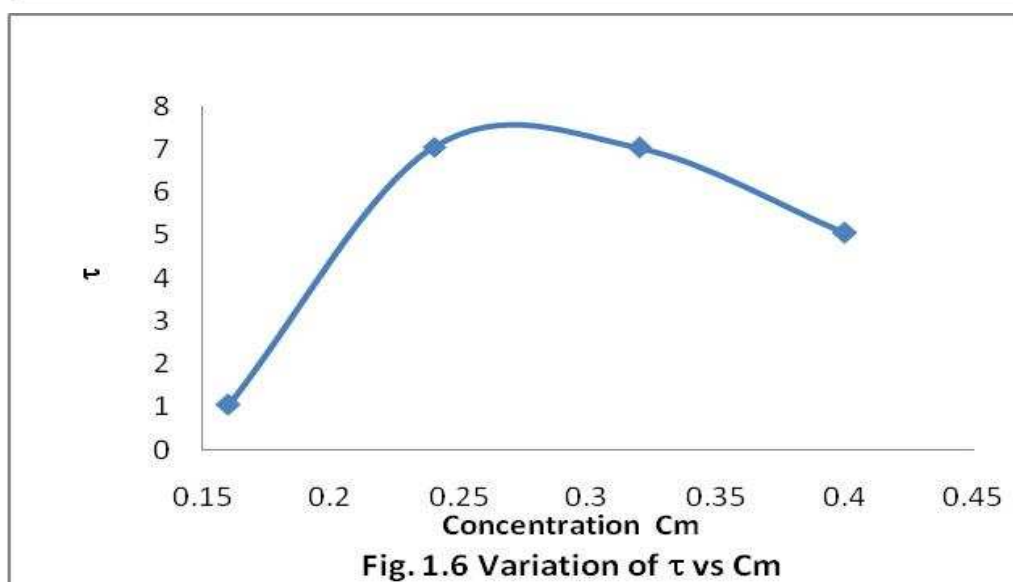
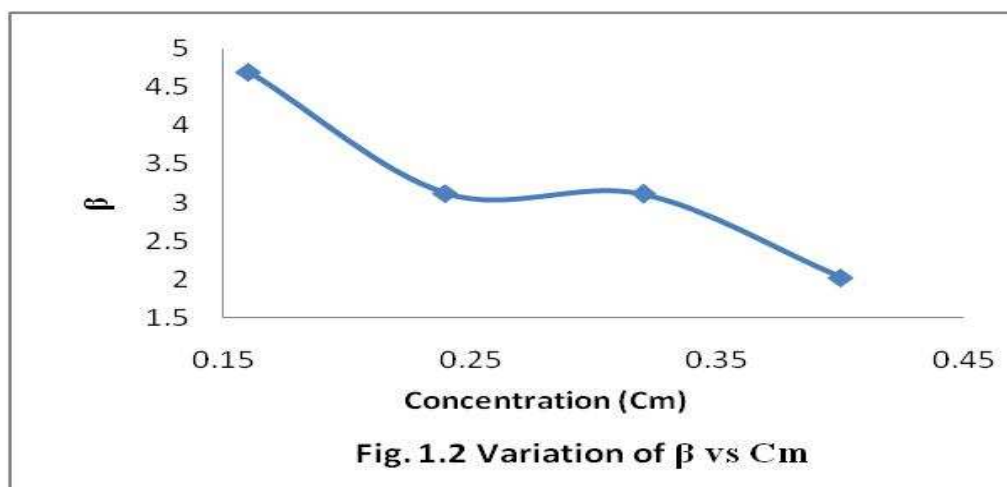
MATERIALS AND METHODS

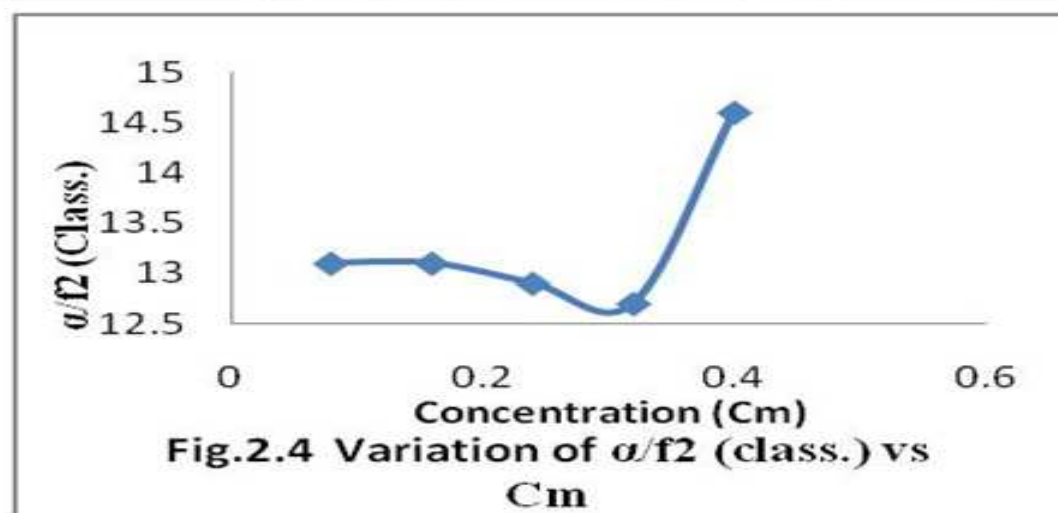
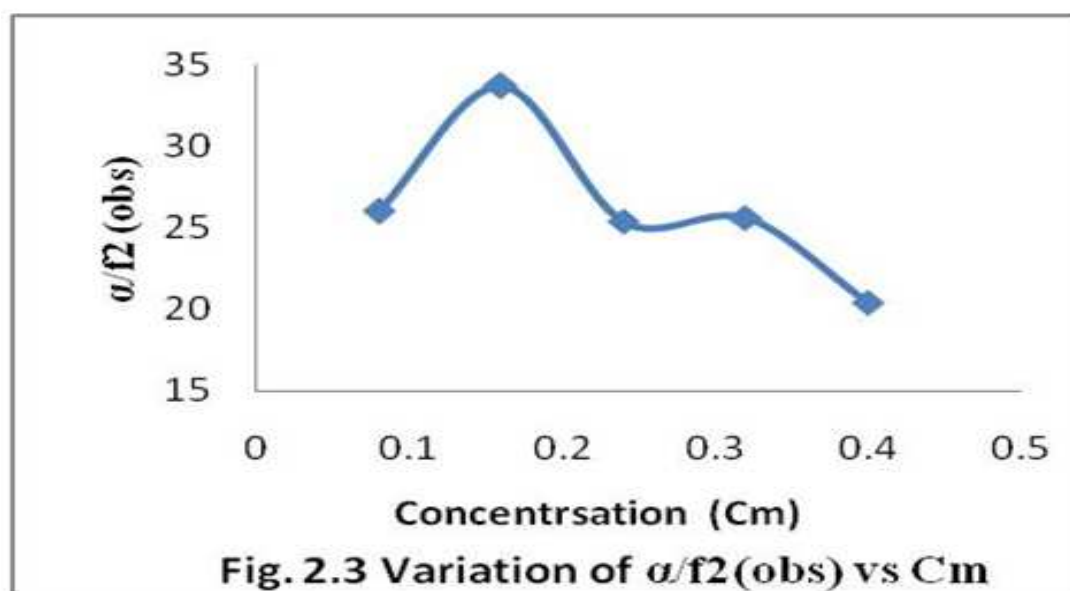
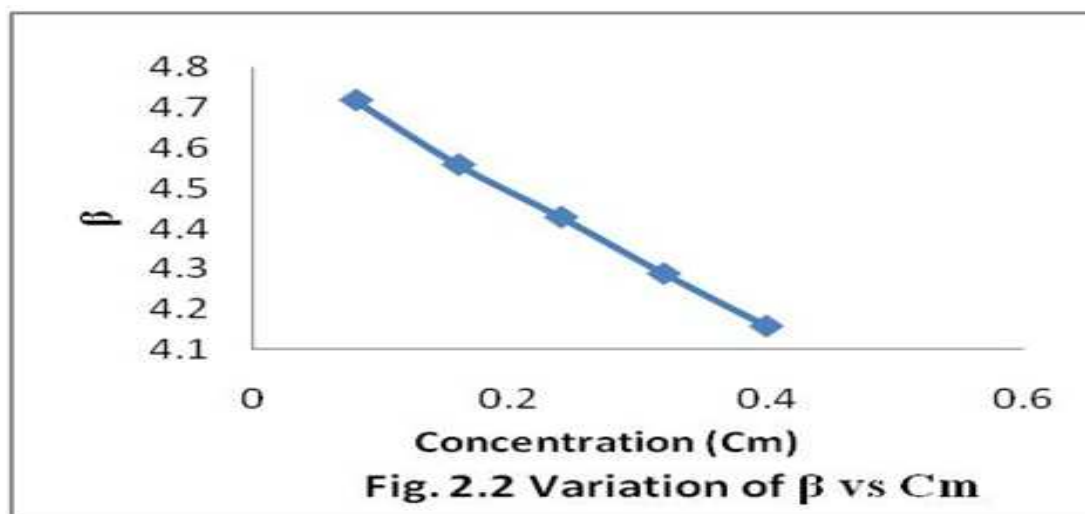
The solution of β -Alanine and L-Glutamic Acid (Monosodium salt) are prepared by dissolving in 100 ml water as per the molecular weight. This solution of having concentration of 0.1M. Water has been used as a solvent. Total 50 ml solution is prepared for the measurement of ultrasonic velocity, absorption, density and viscosity. Biological sample β -Alanine and L-Glutamic acid were mixed with this solvent with different compositions. The chemicals used were of E merck grade and triple distilled water was used. The ultrasonic velocity and absorption measurement were carried out with highly versatile, accurate pulse echo overlap (PEO) technique by using automatic ultrasonic attenuation recorder (AUAR-102) supplied by innovative instruments Hyderabad (India) and frequency counter APLAB-1116. The frequency of the pulses is kept at 2 MHz. The accuracy in the measurement of ultrasonic velocity and absorption of 1 % and 2% respectively. The density and viscosity were measured by employing hydrostatic sinker method and Oswald's viscometer respectively. Thermostatically controlled water circulation system is used to maintain the temperature at 298K with an accuracy of 0.5 °C.

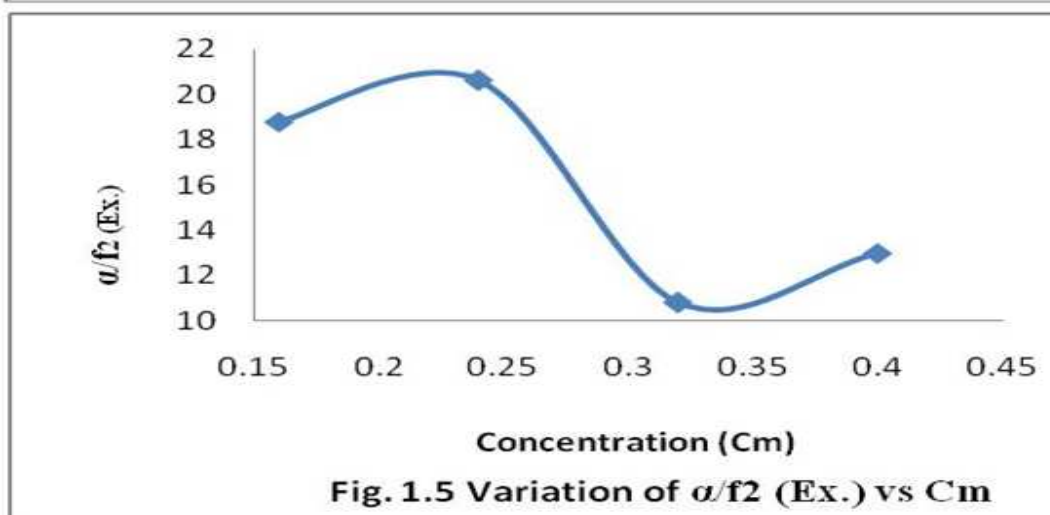
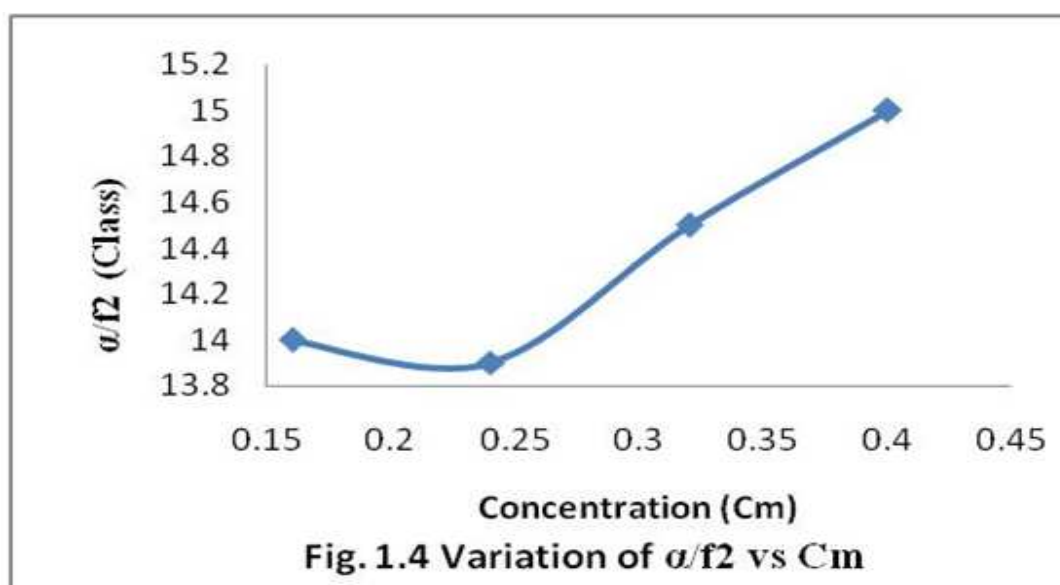
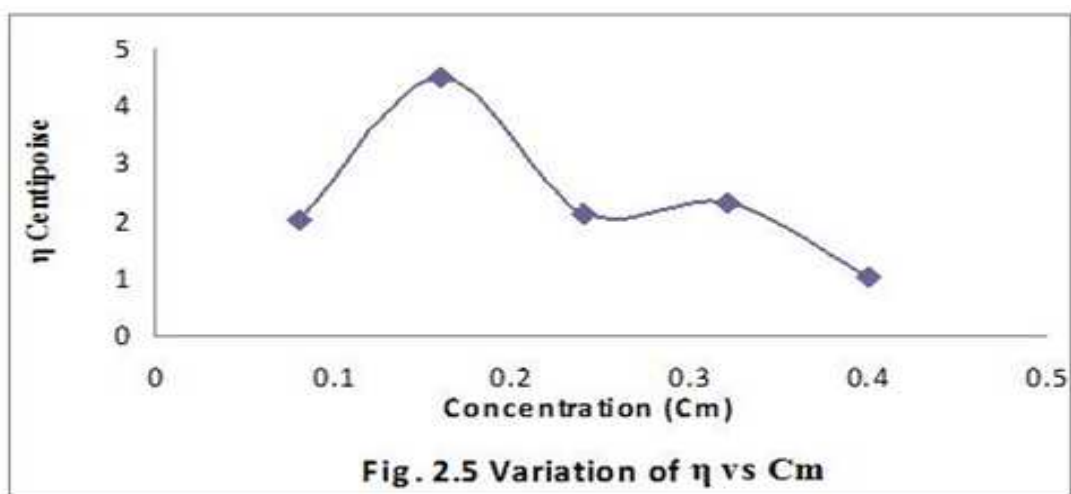
RESULTS AND DISCUSSION

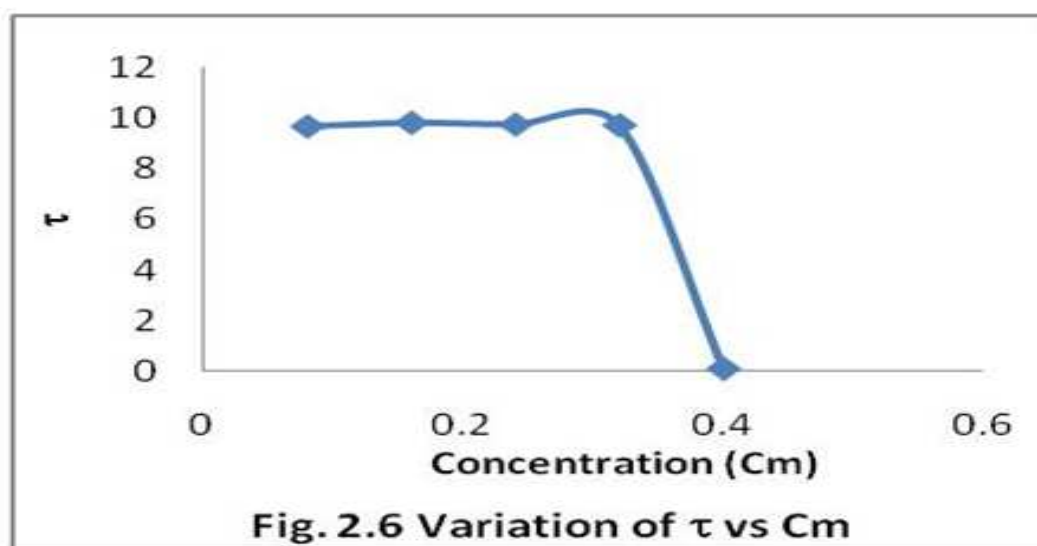
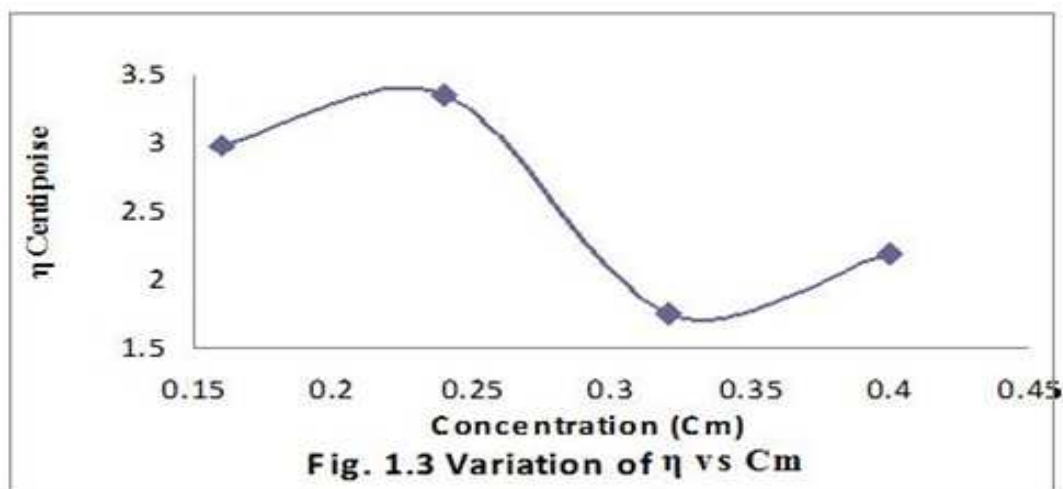
The observed variation in the velocity, absorption and other calculated parameters are shown in table 1 & 2 and graphical representation shown in figures from 1.1 to 2.12.











Aqueous β -Alanine

The variation of ultrasonic velocity, adiabatic compressibility, observed absorption and volume viscosity are shown in fig.1.1 to 1.6 and 2.1 to 2.6 for aqueous β -Alanine and L-Glutamic acid respectively.

In aqueous β -Alanine and L-Glutamic acid, the variation of ultrasonic velocity and adiabatic compressibility with molar concentration shows reverse trends. The ultrasonic velocity increases and adiabatic compressibility decreases with increase in concentration of β -Alanine and L-Glutamic acid in water. But the ultrasonic velocity and adiabatic compressibility are nonlinearly increases in aqueous β -Alanine due to hydrophobic and highly nonpolar nature. The increase in ultrasonic velocity shows the strong association among solute and solvent molecules .i.e. strong solute-solvent interaction. This may be due to the larger probability of amino acid molecules forming the hydrogen bond with water molecules. These results intermolecular forces are stronger. This breaks the cluster of water by the amino acid molecules resulting in enhancing the

closed packed structure of water. Hence the cohesion between water molecules increases, therefore adiabatic compressibility decreases.

The classical absorption and relaxation time shows opposite behaviour. Initially the classical absorption is decreases and relaxation time is increases with molar concentration. Then the classical absorption is increases and relaxation time is decreases from the concentration 0.24. The S-shape variation of observed absorption, excess absorption and volume viscosity shows the three phases of the aqueous β -Alanine.

Aqueous L-Glutamic acid (monosodium salt)

In this system, the variation of ultrasonic velocity is increases and adiabatic compressibility is decreases linearly with molar concentration. This may be due to L-Glutamic acid is highly polar and hydrophilic in nature. Their side chain contains an extra carboxyl group with a dissociative proton. The resulting additional negative charge accounts for the electrochemical behavior of proton.

The variation of classical absorption and relaxation time initially shows small changes with increase in concentration of L-Glutamic acid. But from concentration 0.32, classical absorption is increases and relaxation time decreases rapidly. The variation of observed absorption, excess absorption and volume viscosity shows similar nonlinear behavior and exhibit maximum at concentration 0.16.

The molar concentration which corresponds to the maximum absorption may be called critical concentration. At critical concentration the solution is more structured due to the formation of hydrogen bond. This highly structured solution generally absorbs more ultrasonic energy [5]. The maximum occur at particular concentration may indicate a remote possibility of the formation of an aggregate containing one molecule of amino acid and one molecule of water. These molecular aggregates form large molecular clusters. This aggregation of many small molecules is bound together by cohesive forces [6].

The decreased in observed ultrasonic absorption with increase in molar concentration may be attributed due to the formation of strong hydrogen bonds which generally increases the inter proton distance between adjacent hydrogen bonds. This is also due to the weakening of intermolecular forces of bulk solution and the decrease in non-hydrated free water content of the solution[17,18].

CONCLUSION

The observed variation in the absorption occurs at different concentration in both the systems, conclude that the structure breaking effect of L-Glutamic acid (monosodium salt) is slightly greater than that of β -Alanine. This is because of Glutamic acid has a weakly hydrating charge group and hydrophilic in nature. The nonlinear Ultrasonic absorption shows complex formation, molecular association and hydrogen bond formation in the aqueous biomaterials.

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