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Ultrasonic Analysis of Acoustic and Thermodynamic Properties of a Gylycl Peptide in Non Aqueous Medium

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ABSTRACT

Utrasonic technique is a vital probe in evaluating the thermodynamical parameters such as internal pressure and free volume. The main advantage of considering the internal pressure in calculating the transport properties lies in the fact that it is experimentally measurable and depends on molar volume. By measuring the fundamental parameters, the specific acoustic impedance, Rao's constant, intermolecular free length, internal pressure and free volume were computed. Peptides have been used in the study of protein structure and function. In the present study, non-aqueous solutions of Glycyl-L-Leucine have been taken with different molalities. The density, viscosity and ultrasonic velocities were measured in the temperature range from 278.15 K, 288.15 K, 298.15 K, 308.15 K, 318.15 K, 328.15 K. An attempt will be made to identify the entry of solvate into the sample and the entry of biological molecules in the solvate.

KEYWORDS: Peptides, solute-solute interaction, ultrasonic velocity.

INTRODUCTION

Proteins are of paramount importance for biological system [1]. All the major structural and functional aspects of the body are carried out by the protein molecules. Ultrasonic studies of solutions yield valuable information about the molecular interactions, the nature and strength of the interactions. The measurement of ultrasonic velocity in solution has been found to be an important tool to study the physico-chemical behaviour [2].The concentration and temperature dependence of

acoustic properties has proved to be a significant observation of intermolecular interaction in liquids, liquid mixtures and solutions [3, 4].In the present study, the density, viscosity and ultrasonic velocity of Glycyl-L-Leucine in formamide are measured at various molalities from 278.15 K, 288.15 K, 298.15 K, 308.15 K, 318.15 K, 328.15 K. From the above values, acoustic and thermodynamic parameters are computed.

MATERIALS AND METHODS:

Solutions of Glycyl-L-Leucine of various concentrations are prepared in formamide. Density of the solution is measured using 25ml specific gravity bottle using INSREF constant temperature bath. A digital balance is used with an accuracy of ± 0.0001gm for weighing. Cannon Fenske viscometer is used for the viscosity measurements, with an accuracy of ± 0.1%. Mittal's interferometer of frequency 2 MHZ with an accuracy ±0.1m/s is used for the measurement of ultrasonic velocity.

The following thermodynamic and acoustic parameters are computed using the formula.

Internal pressure (π_i) = bRT $(K\eta / u)^{1/2} * (\rho^{2/3}/M_{eff}^{7/6})$ atms

Free volume (v_f) = $[M_{eff} * U / K\eta)^{3/2}$ cc

Rao's constant (R) = $M_{eff} (U)^{1/3} \rho$

Intermolecular free length (L_f) = $K / [U (\rho)^{1/2}]$ A°

Specific acoustic impedance Z = ρu Rayl.

The results are tabulated in tables (1-5) and shown in graphs (1-5)

Table- (1) Internal pressure (atms)

Molality (m)	278.15K	288.15K	298.15K	308.15K	318.25K	328.15K
0.001	20181	17725	14434	13006	12006	11018
0.005	18869	16585	14136	12914	11887	10798
0.01	19860	16749	14608	13100	12124	10805
0.015	18619	16247	13940	12871	11910	10720
0.02	18924	15588	13683	12513	11661	10555

Table- (2) Free volume (cc)

Molality (m)	278.15K	288.15K	298.15K	308.15K	318.25K	328.15K
0.001	0.008	0.012	0.025	0.037	0.051	0.071
0.005	0.009	0.015	0.026	0.037	0.052	0.075
0.01	0.008	0.014	0.024	0.036	0.049	0.075
0.015	0.010	0.016	0.027	0.038	0.052	0.077
0.02	0.009	0.018	0.029	0.041	0.055	0.080

Table- (3) Rao's constant (R)

Molality (m)	278.15K	288.15K	298.15K	308.15K	318.25K	328.15K
0.001	2143.12	2149.96	2162.62	2174.91	2182.52	2195.45
0.005	2148.35	2159.40	2167.92	2181.34	2186.78	2200.56
0.01	2153.43	2164.43	2173.47	2184.17	2195.62	2204.88
0.015	2157.25	2164.40	2176.12	2191.09	2200.23	2211.62
0.02	2166.53	2174.42	2183.15	2192.63	2205.40	2214.61

Table- (4) Intermolecular free length (A°)

Molality (m)	278.15K	288.15K	298.15K	308.15K	318.25K	328.15K
0.001	0.1073	0.1107	0.1148	0.1187	0.1217	0.1243
0.005	0.1069	0.1104	0.1144	0.1182	0.1211	
0.01	0.1065	0.1100	0.1136	0.1171	0.1199	0.1224
0.015	0.1059	0.1094	0.1134	0.1167	0.1194	0.1221
0.02	0.1055	0.1088	0.1127	0.1163	0.1188	0.1215

Table – (5) Specific acoustic impedance (Rayl)

Molality (m)	278.15K	288.15K	298.15K	308.15K	318.25K	328.15K
0.001	18.83	18.65	18.38	18.00	17.77	17.59
0.005	18.91	18.67	18.43	18.07	17.86	17.67
0.01	18.97	18.73	18.57	18.25	18.04	17.87
0.015	19.08	18.86	18.60	18.31	18.12	17.90
0.02	19.14	18.95	18.71	18.38	18.21	18.01

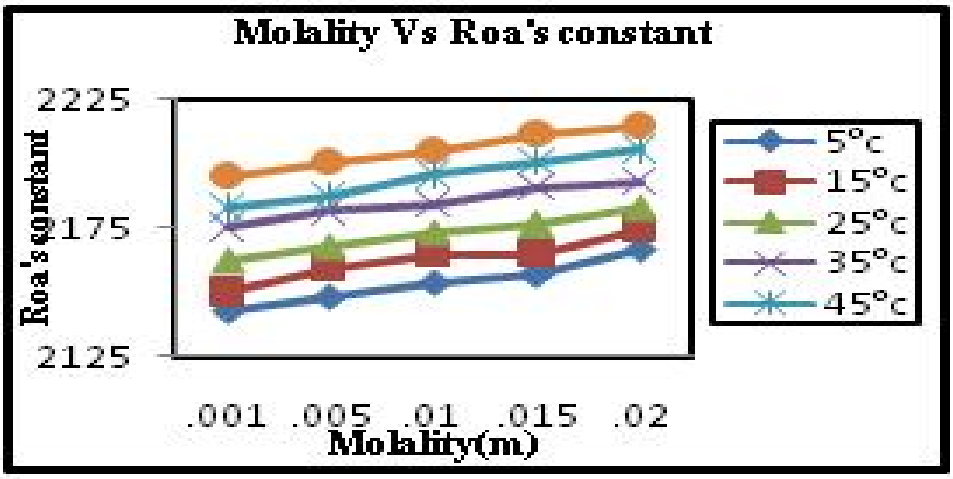

Figure (1) Rao's constant

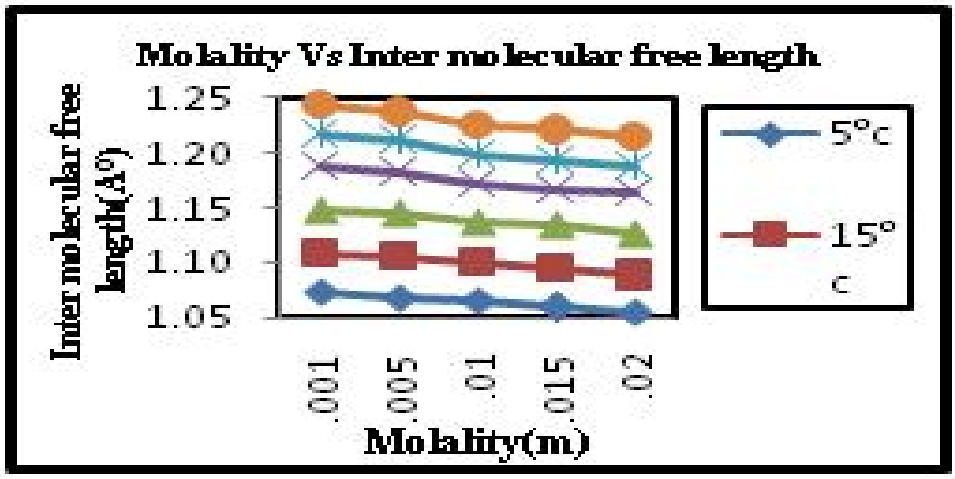

Figure (2) Intermolecular free length (A□)

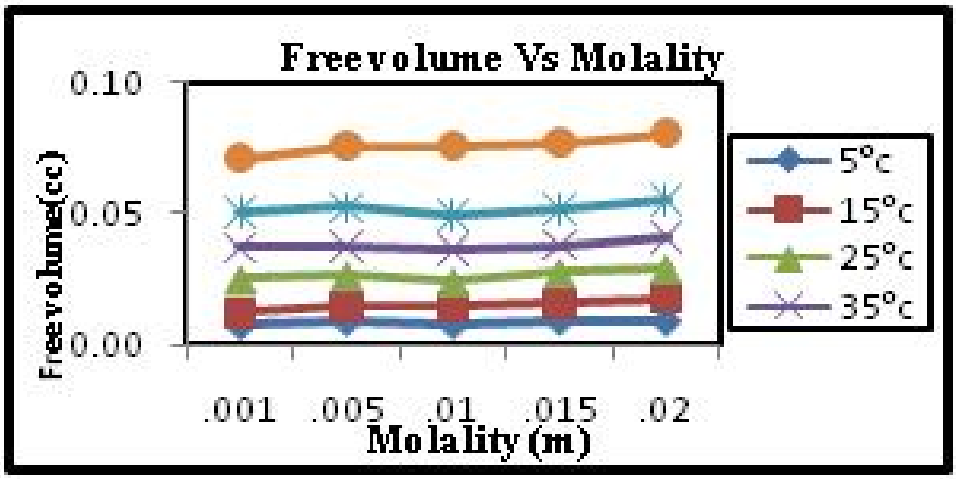

Figure (3) Free volume (cc)

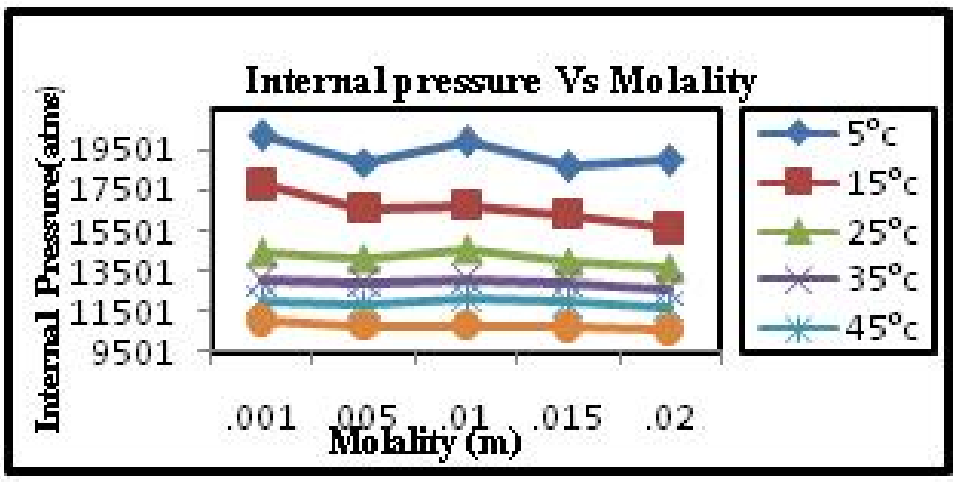

Figure (4) Internal pressure (atms)

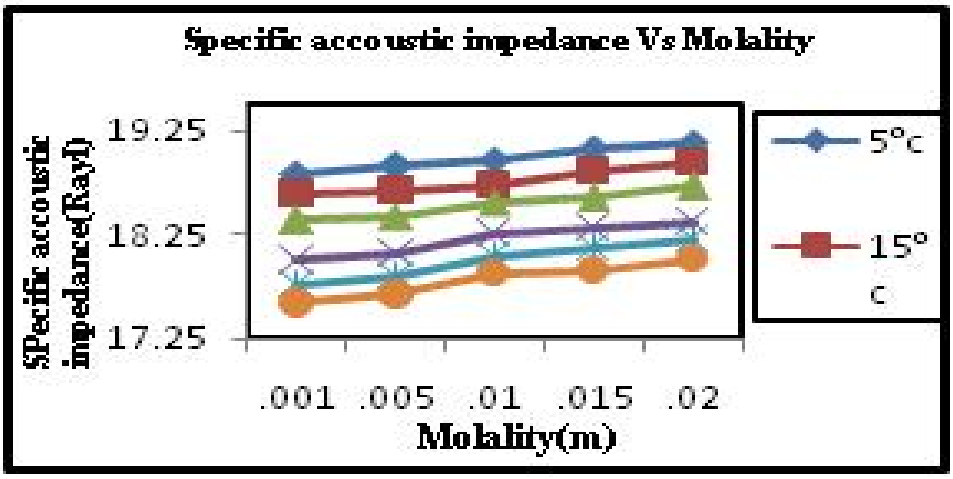

Figure (5) Specific acoustic impedance (Rayl)

RESULT AND DISCUSSION

Suryanarayana and venkatesan [5] recognized that internal pressure of the medium was closely related to degree of dissociation, ionic mobility, ion pairing, dielectric constant and viscosity. In the present investigation, the internal pressure decreases with the rise in temperature because when the temperature is increased, there is a tendency for the ions to move away from each other, reducing the possibility of interaction, which may further reduce the cohesive forces and ultimately leads to a decrease in the internal pressure [6]. In Glycyl-L-Lecucine internal pressure (π_i) is found to increase sharply at 0.01 molality at all temperatures which indicate the strong solute-solvent interaction existing in the solution. This sharp rise may be attributed due to zwitterionicbehaviour of glycyl salts.

Free volume is one of the significant factors in explaining the variations in the physico chemical properties of liquids, solutions and liquid mixtures. The free volume increases with increasing temperature [7] as well as with increasing concentration.Thus due to structural stability, Glycy1-L-Leucine, behaves as a structure maker.

Molar sound velocity or Rao's constant is found to be increasing with increasing concentration and also with increasing temperature for Glycy1-L-Leucine.

When the salt is added to a solvent, the strength of the interaction increases and hence intermolecular free length decreases with molality [8]. In this study, the intermolecular free length is found to decrease with increase in molality and increase with rise in temperature. These changes reveal the fact that there is a strong interaction existing between the solute and the solvent [9].

The specific acoustic impedance (Z) is governed by the internal and elastic properties of the medium. In the present investigation, Z increases with increasing concentration and decreases with increasing temperature, which indicates the absence of complex formation and the existence of solute-solute interaction is identified.

CONCLUSION

The field of protein folding and stability has been a critically important area of research for years.In the present work a detail analysis of acoustic and thermodynamic properties was made.The study reveals the fact that the addition of solute in the solvent enhances the solute-solvent interactions. This behaviourof Glycyl-L-Luecine in formamide emphasizes that it acts as a structure maker due to its structural stability and zwitter ionic nature.

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