Recent Research in Science and Technology 2011, 3(8): 56-63
ISSN: 2076-5061
www.scholarjournals.org

www.recent-science.com

RRST-Physics

Volumetric and Ultrasonic Studies on Interionic Interactions of some Amino Acids in Aqueous Magnesium Acetate Medium at 306.15K

S. Thirumaran* and D. Mary Christina Gardilya

Department of Physics (DDE), Annamalai University, Annamalainagar – 608 002, India

Article Info

Article History

Received : 21-05-2011
Revised : 05-07-2011
Accepted : 05-07-2011

***Corresponding Author**

Tel : +91-9443787882

Email: thirumaran64@gmail.com

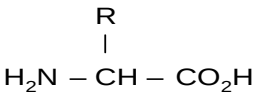
Abstract

The experimental measurements of density (ρ), viscosity (η) and Ultrasonic velocity (U) have been carried out on the amino acids, namely, L-valine, L-lysine and L-histidine which have been mixed with various molar concentrations in aqueous magnesium acetate solution in different molarities (0M, 0.4M & 0.8M) at a temperature of 306.15K. Using these experimental values, the acoustical parameters such as adiabatic compressibility (β), molar hydration number (n_H), apparent molar compressibility (φ_K), apparent molar volume (φ_V), limiting apparent molar compressibility (φ_K^0), limiting apparent molar volume (φ_V^0) and the constants (S_K, S_V) at infinite dilution were evaluated. Transfer Volume ($\Delta\varphi_V^0$) at infinite dilution from water to aqueous magnesium acetate solutions has been determined. In addition, Viscosity A and B coefficients of Jone-Dole equation have also been evaluated from viscosity measurements. Eventually, these parameters have been critically analyzed and emphasizing the possible interionic interactions such as ion-ion, solute-solvent, ion-solvent, solute-co-solute etc., and discussed in terms of structure-making and structure-breaking effects of the amino acids in the solvent mixture.

Key Words: Molar hydration number, Apparent molar compressibility, Apparent molar volume, Structure-maker

Introduction

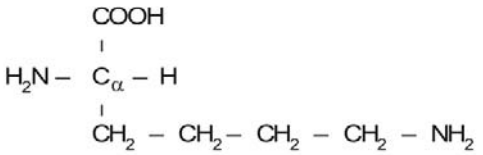
Ultrasonic study on the amino acids with aqueous solution of electrolytes and non-electrolytes provides useful information in understanding the behaviour of liquid systems, intramolecular and intermolecular associations, complex formation and related structural changes. For the past two decades, a considerable study has been carried out to investigate the hydration of proteins through volumetric and ultrasonic measurements, since these properties are sensitive to the degree and nature of hydration [1-3]. Due to the complex molecular structure of proteins, direct study is somewhat difficult. Therefore, the useful approach is to study simpler model compounds, such as amino acids which are building blocks of proteins. Most of the studies on amino acids [4,5] have been carried out in pure and mixed aqueous solution. The investigation of volumetric and thermodynamic properties of amino acids and peptides in aqueous and mixed aqueous solvents has been the area of interest of a number of researchers [6-8] Proteins are formed by polymerizing monomers that are known as amino acids, because they contain an amino ($-NH_2$) and a carboxylic acid ($-CO_2H$) functional group. With the exception of the amino acid, proline, which is a secondary amine, the amino acids used to synthesize proteins are primary amines with the following general formula



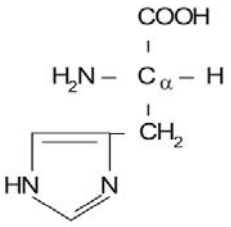
These compounds are known as α-amino acids, because the $-NH_2$ group is on the carbon atom next to the $-CO_2H$ group, the so-called carbon atom of the carboxylic acid.

Amino acids with non-polar substituents are said to be hydrophobic (water hating). Amino acids with polar R-groups that form hydrogen bonds with water are classified as hydrophilic (water loving). The remaining amino acids have substituents that carry either negative or positive charges in aqueous solutions are neutral pH and are therefore strongly hydrophilic.

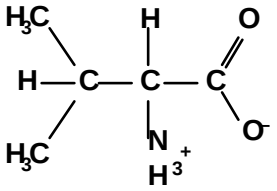
In the present investigation, we studied at neutral pH, the amino acids which are taken up for are L-valine, L-lysine and L-histidine. The structural formula for L-valine, L-lysine and L-histidine are given as.



L-lysine



L-histidine



L-valine

Incidentally, the knowledge of the interactions responsible for stabilizing the native state of globular protein in aqueous solution is essential to understand its structure and function. The study of these interactions provides an important insight into the conformational stability and unfolding behavior of globular proteins. Due to complex structure of protein, the study of conformational stability and unfolding behavior of globular protein has proved quite challenging and still remains a subject of extensive investigations. Therefore, protein model compounds such as amino acids and peptides, which are basic components of proteins have been investigated in detail with respect to their thermodynamic properties in aqueous and mixed aqueous solutions.

The noted effects by the salts on the stability of protein structures and some electrolytes have a tendency to disrupt some of the structural features of proteins, whereas other electrolytes show property to buttress such structures [9]. The study of the thermodynamic ability of the native structure of proteins has proved quite challenging [10]. The authors in their literature survey noticed that salt solutions have large effects on the structure and properties of proteins including their solubility, denaturation, dissociation into subunits.. But L-amino acids are used in many biological processes in human body like transamination, decarboxylation and metabolism. On the other hand, L-amino acids are also involved in intracellular metabolism and operate specific transport systems of the plasma membrane. Hence, the authors felt that the study of these model compounds (amino acids) in aqueous salt solutions is more significance in understanding the effects of salts on biomolecules.

Further, the authors noticed that various workers have studied the interaction between some amino acids and simple slats [11,12] which act as stabilizer/destabiliser, but a few studies are available about the behavior of amino acids in the presence of organic salts. Most of the works on amino acids has been carried out in dilute electrolytic solutions. Although various studies of amino acids are available in the presence of electrolytes, but no report has been found in the presence of organic salts having divalent cation such as magnesium acetate. Magnesium acetate has been used as organic salt because magnesium found immense importance in biological chemistry [15]. Moreover, no systematic studies are available on the thermodynamic and transport properties of amino acids having polar side group (chain) in the presence of organic salt solutions.

In the present study, we have reported that the values of density, viscosity and ultrasonic velocity have been measured for the amino acids, L-valine, L-lysine and L-histidine in aqueous magnesium acetate solution at 306.15K. The related parameters which are relevant to our study such as adiabatic compressibility (β), molar hydration number (n_H), apparent molar compressibility (φ_k), apparent molar volume (φ_v), limiting apparent molar compressibility (φ_K^0) and its related constant (S_K), limiting apparent molar volume (φ_V^0) and its related constant (S_V), transfer volume ($\Delta\varphi_V^0$) and Viscosity-B coefficients of Jones-Dole equations have been evaluated and discussed the possible inter-ionic interactions in terms of ion-solvent, solute-solvent, solute-solute, ion-ion etc., occurring between the amino acids and aqueous magnesium acetate solution.

Materials and Methods

We have used analytical reagent grade (AR) and spectroscopic reagent (SR) with minimum assay of 99.9% of L.valine, L-lysine and L-histidine obtained from E-Merk, Germany and Sd fine Chemicals, India, for this present study. Water used in the experiments was deionised, distilled and degassed prior to making solutions. Aqueous magnesium acetate at two different molarities(M) [say, at 0.4M and at 0.8M] were prepared by volume and used on the day they were prepared. Solutions of amino acids in the concentration range of 0.02 – 0.1M were made by volume on the molarity (M) concentration scale with a precision of 0.0001g using an electronic digital balance [Model: SHIMADZU AX-200].The density of liquid mixtures was determined using a specific gravity bottle by relative displacement method with an accuracy of ±0.01kgm^{-3}.An Ostwald's Viscometer (10ml capacity) was used for the viscosity measurements with efflux time was determined using a digital chronometer to within ±0.01s. An ultrasonic interferometer having the frequency of 3 MHz (Mittal Enterprises, New Delhi, Model-F-81) with overall accuracy of 3 ms^{-1} has been used for velocity measurements. An electronically digital operated constant temperature bath(RAGAA Industries, Chennai) has been used to circulate water through the double walled measuring cell made up of steel containing the experimental solution at the desired temperature. The accuracy in the temperature measurement is ± 0.1K.

Results and Discussion

It is interesting to note that in all the amino acid systems from Table 1, the values of density, viscosity and ultrasonic velocity increases with increase of molar concentration of amino acids as well as the increasing content of the magnesium acetate. Also, from Table 1, the ultrasonic velocity (U) increases with increase in the concentration of the solute as well as rise in magnesium acetate content. Such an increase in ultrasonic velocity (U) suggesting the possibility of a molecular association in these liquid mixtures.

The measured and observed parameter like density (ρ) is a measure of solvent-solvent and ion-solvent interactions. Increase of density with concentration indicates the increase in solvent-solvent and solute-solvent interactions, whereas the decrease in density indicates the lesser magnitude of solute-solvent and solvent-solvent interactions. Increase in density with concentration is due to the shrinkage in the volume which in turn is due to the presence of solute molecules. In other words, the increase in density may be interpreted to the structure-maker of the solvent due to the added solute. Similarly, the decrease in density indicates structure-breaker of the solvent. It may also be true that solvent-solvent interactions bring about a bonding, probably hydrogen bonding between them. Subsequently, size of the resultant molecule increases and hence there will be decrease in density. The change in structure of solvent or solutions as a result of hydrogen bond formation or dissociation or hydrophobic (structure-breaking) or hydrophilic (structure-forming) character of solute.[16]

Table 1: Values of density (ρ), viscosity (η) and ultrasonic velocity (U) in aqueous magnesium acetate mixtures at 306.15 K

Molarity M/(mol.dm^{-3})	Density ρ/(kg/m^3)			Viscosity η/(×10^{-3} Nsm^{-2})			Ultrasonic Velocity U/(m/s)		
	WATER + MAGNESIUM ACETATE								
	0 M	0.4 M	0.8 M	0 M	0.4 M	0.8 M	0 M	0.4 M	0.8 M
System I: L - lysine									
0.00	994.74	1060.41	1095.57	0.7490	1.0186	1.7655	1502.9	1574.4	1633.42
0.02	996.24	1062.21	1096.87	0.7551	1.0336	1.7804	1504.25	1576.57	1635.66
0.04	997.31	1063.38	1097.83	0.7632	1.0351	1.7891	1505.18	1577.61	1636.43
0.06	998.36	1064.48	1098.90	0.7698	1.0481	1.7956	1506.27	1578.81	1637.51
0.08	999.27	1065.39	1099.96	0.7759	1.0545	1.8007	1507.18	1579.78	1638.32
0.10	999.98	1066.51	1100.81	0.7808	1.0608	1.8075	1508.41	1580.65	1639.27
System II: L-histidine									
0.00	994.74	1060.41	1095.57	0.7490	1.0186	1.7655	1502.9	1574.4	1633.42
0.02	995.81	1062.72	1096.61	0.7608	1.0291	1.7698	1505.30	1575.81	1634.48
0.04	996.54	1063.81	1097.78	0.7691	1.0388	1.7759	1506.81	1576.69	1635.55
0.06	997.08	1064.69	1098.85	0.7765	1.0475	1.7811	1507.94	1577.74	1636.67
0.08	997.97	1065.60	1099.77	0.7819	1.0577	1.7891	1508.99	1578.91	1637.63
0.10	998.63	1066.54	1100.68	0.7901	1.0660	1.7960	1510.04	1579.89	1638.59
System III: L-valine									
0.00	994.74	1060.41	1095.57	0.7490	1.0186	1.7655	1502.9	1574.4	1633.42
0.02	996.04	1061.78	1096.32	0.7570	1.0246	1.7735	1503.70	1576.04	1634.81
0.04	996.91	1062.57	1097.09	0.7652	1.0327	1.7804	1504.53	1577.02	1635.74
0.06	997.73	1063.32	1097.94	0.7737	1.0403	1.7882	1505.36	1577.97	1636.65
0.08	998.52	1064.05	1098.73	0.7803	1.0486	1.7963	1506.03	1578.86	1637.58
0.10	999.35	1064.88	1099.56	0.7889	1.0564	1.8041	1506.91	1579.64	1638.47

It may be ascribed that the increasing trend of ultrasonic velocity (U) in these solutions may be due to the cohesion brought about by the ionic hydration. The factors apparently responsible for such behavior may be the presence of interactions caused by the proton transfer reactions of amino acid in water + magnesium acetate mixtures. It is known that water + magnesium acetate mixtures of L-Lysine, L-histidine and L-valine, contain in addition to the uncharged molecules NH_2CH_2COOH, an electrically neutral molecule viz., $NH^+{}_3CH_2COO^-$ dipolarions (Zwitterions).

Further it may be correlated that when the amino acids are dissolved in water + magnesium acetate mixtures, the cations Mg_2^+ and the anions COO^- are formed. The water molecules are attached to the ions strongly to the electrostatic forces, which introduce a greater cohesion in the solutions [17], resulting in increase of cohesion, whenever amino acid concentration in the solution increases. Such an increased association observed in these solutions may also be due to the water structure enhancement brought about by the increase in electrostriction in the presence of magnesium acetate. The electrostriction effect which brings about the shrinkage in volume of solvent caused by the Zwitterionic portion of the amino acids is found to be increased in mixed solvent. Similar effect were reported by earlier workers [13,14]. The perusal of Table 2 shows the variation of adiabatic compressibility (β) with molar concentration of amino acids. The values of β in all the three amino acids systems exhibiting a decreasing trend. It also noticed that the same paprameter decreases, on increasing the content of the magnesium acetate. The adiabatic compressibility's values are larger in L-valine system than those of other amino acid systems, suggesting that the molecular association is greater in L-valine. Amino acid molecules in the neutral solution exist in dipolar form and then have stronger interaction with the surrounding water molecules. The increasing electrostrictive compression of water around the molecules results in a larger decrease in the compressibility of the solutions.

Table 2: Values of adiabatic compressibility (β) and molar hydration number (nH) in aqueous magnesium acetate mixtures at 306.15 K

Molarity M/(mol.dm^{-3})	Adiabatic Compressibility β (×10^{-10} m^2 N^{-1})			Molar Hydration Number (n_H x10^{-1})		
	0 M	0.4 M	0.8 M	0 M	0.4 M	0.8 M
System I: L - lysine						
0.00	4.4506	3.8044	3.4211	…	…	…
0.02	4.4360	3.7875	3.4076	0.0574	0.0714	0.0579
0.04	4.4258	3.7744	3.4014	0.0485	0.0632	0.0421
0.06	4.4147	3.7687	3.3993	0.0469	0.0501	0.0311
0.08	4.4057	3.7609	3.3870	0.0438	0.0457	0.0304
0.10	4.3951	3.7528	3.3805	0.0434	0.0413	0.0247
System II: L-histidine						
0.00	4.4506	3.8044	3.4211	…	…	…
0.02	4.4317	3.7894	3.4166	0.0645	0.0550	0.0316
0.04	4.4196	3.7813	3.4053	0.0326	0.0423	0.0297
0.06	4.4105	3.7731	3.3973	0.0453	0.0382	00295
0.08	4.4005	3.7643	3.3905	0.0426	0.0367	0.0278
0.10	4.3915	3.7563	3.3837	0.0402	0.0352	0.0274
System III: L-valine						
0.00	4.4506	3.8044	3.4211	…	…	…
0.02	4.4401	3.7916	3.4129	0.0639	0.0838	0.0544
0.04	4.4314	3.7841	3.4066	0.0584	0.0665	0.0483
0.06	4.4228	3.7769	3.4002	0.0564	0.0601	0.0464
0.08	4.4154	3.7700	3.3939	0.0528	0.0564	0.0452
0.10	4.4066	3.7634	3.3876	0.0504	0.0537	0.0446

It is known that the interaction between the solute and the water molecules in the solvent is referred to as hydration. This parameter is an added support for the structure promoting nature of solutes as well as the presence of dipolar interaction between the solute and water molecules. This also suggests that compressibility of the solution will be less than that of the solvent. As a result solutes will gain mobility and have more probability of contacting solvent molecules. This may enhance the interaction between solute and solvent molecules. From Table 2, our present study shows that the values of hydration number (n_H) are positive in all the systems and such positive values of n_H indicate the appreciable salvation of solute. It is also observed that the values of hydration number decreases in L-valine, L-lysine systems and L.histidine with increasing molarities of the solute, as well as with increase in magnesium acetate content in all the three systems. The decreasing values of n_H which indicate the increase in solute-solvent interaction and vice–versa. Such a decrease in n_H values with increase of molarities of the solute concentration leading to the reduction in the electrostriction, which lead to suggest that the magnesium acetate has a dehydration effect on the amino acids.

We observed the following observations made on apparent molar compressibility (φ_K) and apparent molar volume (φ_V) of L-valine, L-lysine and L-histidine in aqueous magnesium acetate solution at 306.15K are tabulated in Table 3.

Table 3: Values of apparent molar compressibility (φ_k) and apparent molar volume (φ_v) in aqueous magnesium acetate mixtures at 306.15 K

Molarity M/(mol.dm^{-3})	Apparent Molar Compressibility $-\varphi_k$(×10^{-8} m^2 N^{-1})			Apparent Molar Volume $-\varphi_v$(×m^3 mol^{-1})		
	0 M	0.4 M	0.8 M	0 M	0.4 M	0.8 M
System I: L - lysine						
0.02	10.6847	13.1325	10.5380	73.6122	95.4368	71.2120
0.04	8.9575	11.4289	8.0289	63.4159	78.735	61.8997
0.06	8.5771	9.4271	7.4411	59.6855	71.9311	60.8041
0.08	8.0497	8.6256	7.1729	56.0795	66.0105	60.1194
0.10	7.8030	8.2631	6.8370	51.9264	64.6850	57.4078
System II: L-histidine						
0.02	11.6755	13.0930	7.6496	52.2248	122.4773	62.4474
0.04	9.6391	9.9229	6.8188	44.2668	90.1348	61.3519
0.06	8.3088	8.7437	6.8100	39.4640	75.6425	59.8911
0.08	7.9734	8.2536	6.5587	38.6912	68.7940	57.5174

0.10	7.5615	7.8816	6.4042	38.4972	65.0031	55.9836
System III: L-valine						
0.02	8.0285	9.9600	6.6257	63.6646	72.6380	45.0838
0.04	7.1294	7.8851	5.7752	53.4683	57.2621	44.6316
0.06	6.7764	7.1104	5.6614	49.2406	51.4298	43.2750
0.08	6.4348	6.6707	5.5614	46.7537	48.2486	43.2650
0.10	6.3861	6.4136	5.5163	45.6594	47.4003	42.7132

i.The values of the (φ_K) and (φ_V) are all negative over the entire range molarity of amino acids.

ii.The (φ_K) values are increasing with increasing molarity of the solute in L-valine, L-lysine and L.histidine amino acid systems.

iii.Similarly, the (φ_V) values also increase with increasing molarity of solute in all three systems.

iv.Also, both (φ_K) and (φ_V) increase with increase in magnesium acetate content in all the three amino acid systems.

v.The maximum values of apparent molar compressibility (φ_K) as well as apparent molar volume (φ_V) are obtained for L-valine system, which suggests electrostriction and hydrophilic interactions are occurring in these systems, indicating the presence of solute-solvent interactions.

vi.It can be seen that from the magnitudes of (φ_K) and (φ_V), the molecular association between the three systems of amino acids are of the order: L-valine > L-histidine > L-lysine

All the above observations clearly suggest that the negative values of (φ_K) indicate ionic, dipolar and hydrophilic interactions occurring in these systems. Since more number of water molecules are available at lower concentration of magnesium acetate, the chances for the penetration of solute molecules into the solvent molecules are highly favored. Further, the increasing values of (φ_K) in the concerned systems revealing the less strengthening in solute-solvent interactions existing in these mixtures. Further, it also can be seen that the negative values of (φ_V) in all the systems indicate the presence of solute-solvent interactions. The increasing value of (φ_V) is due to moderate ion-solvent interactions. The negative values of (φ_V) are attributed due to the electrostrictive salvation of ions [18]. From the magnitude of (φ_V), it can be concluded that the strong molecular association is found in L-valine system than other two systems and hence , it can be presumed as L-valine is a more effective structure-maker than other two amino acids.

The Limiting apparent molar compressibility (φ_k^0) values provide information regarding the solute-solvent interaction and its related constant (S_K) of the solute-solute interaction in the solution, which are reported in Table 4. These φ_K^0 values are negative in all the systems and increase with rise in content of magnesium acetate. Appreciable negative values of φ_K^0 for all the systems lead to suggest the existence of solute-solvent interactions. The values of S_K exhibit positive values and decrease with increase of magnesium acetate content. Such a behavior shows that the existence of ion-ion/solute-solute interactions in all the three systems studied. It is well known that solutes causing electrostriction that lead to decrease in the compressibility of the solution, which is reflected in the negative values of φ_K of amino acids in aqueous magnesium acetate solution [19].

The perusal of Table 4 represents the values of Limiting apparent molar volume (φ_V^0) which exhibit negative values in all the three systems studied. Further, the φ_V^0 values increase with increase in contents of magnesium acetate. The increasing trend is due to disruption of side group hydration by that of the charged end. The increase in φ_V^0 may be attributed to the increased hydrophilicity/polar character of the side chain of the amino acids. It is evident from the Table 4 that the positive values of S_V in all the three amino acid systems clearly indicate the presence of strong solute-solute interaction. Further, these values suggest the magnesium acetate has induced effect on the solute-solute interaction, which have the possibility of both the increasing polar part of the amino acids and dependence of the behavior of magnesium acetate concentration in aqueous medium.

Table 4: Limiting apparent molar compressibility (φ_k^0), Limiting apparent molar volume (φ_v^0), their constants S_k and S_v and Transfer volume ($\Delta\varphi_v^0$) of Amino acids

Amino Acids	Limiting Apparent Molar Compressibility φ_k^0 /(×10⁻⁸ m² N⁻¹)			Constant S_K / (×10⁻⁸ N⁻¹ m⁻¹ mol⁻¹)			Limiting Apparent Molar Volume φ_v^0 / (× m³·mol⁻¹)			Constant S_V / (N⁻¹ m⁻¹ mol⁻¹)			Transfer Volume $\Delta\varphi_v^0$ / (× 10³ m³·mol⁻¹)		
	0 M	0.4 M	0.8 M	0 M	0.4 M	0.8 M	0 M	0.4 M	0.8 M	0 M	0.4 M	0.8 M	0 M	0.4 M	0.8 M
L-lysine	−17.62	−20.35	−16.00	37.03	42.75	33.62	−121.88	−150.71	−124.57	256.06	316.63	261.71	…	-28.83	-2.69

L-histidine	–18.06	–19.16	–13.69	37.94	40.16	28.76	–85.25	–168.82	–118.87	179.11	354.66	249.87	…	-83.57	-33.62
L-valine	–13.90	–15.21	–11.64	29.20	31.96	24.46	–86.99	–110.79	–87.58	217.46	232.75	184.01	…	-23.80	-0.59

In the present amino acid systems, it may be presumed that the interactions may be taking place as,

1. ion-dipolar / hydrophilic group interactions between the ions of magnesium acetate (Mg^{2+},CH_3 COO^-) and (NH_3^+,COO), (–OH) group of amino acids [20].
2. ion-hydrophilic group interaction between the ions of magnesium acetate and polar parts of amino acids.
3. hydrophilic-ionic interaction between the Mg^{2+}, COO- group of magnesium acetate and Zwitterionic centres of the amino acids.
4. hydrophilic-hydrophobic interaction between the Mg^{2+}, COO- group of magnesium acetate molecules and OH of the amino acids.

The transfer volume ($\Delta\varphi_V^0$) values are reported in Table 4, which can be explained on the basis of co-sphere overlap model [21] in terms of solute-co-solute interactions. According to this model, the hydrophilic –ionic group interactions contribute positively, whereas hydrophobic-hydrophobic group interactions contribute negatively. Therefore, from Fig. 1, the negative $\Delta\varphi_V^0$ values observed for L-valine, L-lysine and L-histidine from the present study suggest that latter type of interactions are dominating over the former.

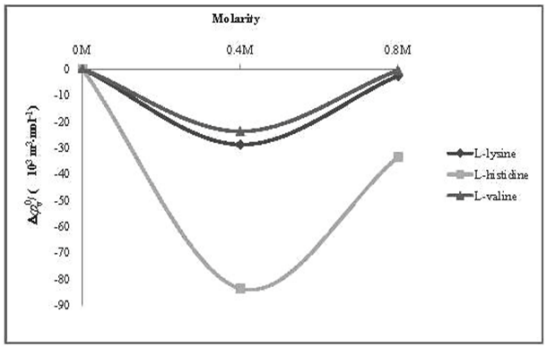


Fig. 1: Variation of transfer volume ($\Delta\varphi_V^0$) with molarity (M)

Viscosity is an important parameter in understanding the structure as well as molecular interactions occurring in the solutions. From Table 1, it is observed that the values of viscosity increases with increase in solute concentration in all the systems. Such an increasing trend indicates the existence of molecular interaction occurring in these systems.

Table 5: Values of A and B parameters of Jones-Dole equation of Amino Acids

Amino Acids	A (× $dm^{-3/2}$ $m^{-1/2}$)			B (×dm^3 mol^{-1})		
	0 M	0.4 M	0.8 M	0 M	0.4 M	0.8 M
L-lysine	0.00523	0.0634	0.0532	0.4623	0.2029	0.0634
L-histidine	0.07000	0.0092	- 0.157	0.3100	0.4408	0.2214
L-valine	-0.0013	-0.0255	-0.00052	0.5385	0.4597	0.2174

In order to shed more light on this, the role of viscosity B-coefficient has also been evaluated. From Table 5, it is observed that the values of A are positive as well as negative and B-coefficients are positive in all systems. Since A is a measure of ionic interaction [22] it is evident that there is a weak as well as strong ion-ion interactions present in the liquid mixtures. The B-coefficient which is known for measure of order or disorder introduced by the solute in the solvent. It is also a measure of solute-solvent interaction. The behaviour of B-coefficient in all the amino acids suggests the existence of strong solute-solvent interaction. The magnitude of B-values is higher in L-valine which clearly confirms the amino acid L-valine is acting as a effective structure-maker in aqueous magnesium acetate solution. Similar trends of interaction studies studied for other amino acids in aqueous magnesium acetate solution have been reported earlier [20], which supports the present investigation. From the magnitude of B-Coefficient, it can be concluded that the molecular interaction between the amino acids is of the order: L-valine > L-histidine > L-

lysine. The above conclusion confirms well with our earlier agreement with that drawn from φ_k and φ_v data.

Conclusion

In the light of the above discussion, it may be concluded that intermolecular interaction of electrostriction and hydrophilic nature exist in the systems studied. The existence of ion-solvent or solute-solvent interactions resulting in attractive forces which promote the structure-making tendency, while ion-ion or solute-solute interaction resulting dipole-dipole, dipole-induced dipole and electrostrictive forces enhance the structure-breaking properties of amino acids. In the present investigation, by analysing all the evaluated parameters clearly suggesting that L-valine is a strong structure maker in aqueous magnesium acetate solution over the other two amino acids. Hence, in the present study the molecular interaction follows the order**:** L-valine > L-histidine > L-lysine. The transfer volume studies predict that hydrophobic – hydrophobic group interactions are dominating over that of hydrophilic – ionic group interactions between solute-co-solute molecules.

Ultrasonic velocity, density and viscosity have been measured for three amino acids viz, L-valine, L-lysine and L-histidine in aqueous magnesium acetate solution at 306.15K which have biological and biochemical relevance. The dipolar (zwitterions) characteristics of these organic liquid molecules shed light on solute-solvent interactions in aqueous magnesium acetate mixtures have proved to be the most interesting due to its univalent character. There is much scope for further studies in these systems by varying pH of the solution and temperature which may reveal more interionic interactions existing between solute-solvent molecules. Hence it is evident that the ultrasonic velocity measurement in the given medium serves as a powerful probe in characterising the physico-chemical properties of that medium**.**

References

[1] Millero, F.J., Antonio Lo Surdo, and Charles Shin.1978. The apparent molal volumes and adiabatic compressibilities of aqueous amino acids at 25°C. J. Phys. Chem. 82: 784–792.

[2] Cabani, S., Giovanni Conti, Enrico Matteoli and Maria R. Tiné. 1981. Volumetric properties of amphionic molecules in water. Part 2. Thermal expansibility and compressibility related to the formation of zwitterionic structures. J. Chem. Soc. Faraday Trans. 1, 77: 2385 – 2394.

[3] Hoiland, H. 1980. Partial molal volumes, expansibilities, and compressibilities for aqueous alcohol solutions between 5°C and 40°. J. Sol. Chem. 9: 857-866.

[4] Hedwig, G.R., and H. Hoiland. 1991. Thermodynamic properties of peptide solutions 8. Isentropic pressure coefficients (∂ V2,/∂p)s of the apparent molar volume V2, for each of the aqueous solutes: diglycine, triglycine, and tetraglycine. J. Chem. Thermodyn. 23: 1029-1053.

[5] Bhat, R., and Jagdish C. Ahluwalia. 1985. Partial molar heat capacities and volumes of transfer of some amino acids and peptides from water to aqueous sodium chloride solutions at 298.15 K. J. Phys. Chem. 89: 1099-1105.

[6] Wadi K. Ramesh, and P. Ramasami. 1997. Partial molal volumes and adiabatic compressibilities of transfer of glycine and DL-alanine from water to aqueous sodium sulfate at 288.15, 298.15 and 308.15 K. J. Chem. Soc. Faraday Trans. 93: 243-247.

[7] Duke, M.M., Andrew W. Hakin, Robert M. McKay, and Kathryn E. Preuss. 1994. The volumetric and thermochemical properties of aqueous solutions of L-valine, L-leucine, and L-isoleucine at 288.15, 298.15, 313.15, and 328.15K. Can. J. Chem. 72: 1489-1494.

[8] Hakin, A.W, Michelle M. Duke, Sheri A. Klassen, Robert M. McKay, and Kathryn E. Preuss. 1994. Apparent molar heat capacities and volumes of some aqueous solutions of aliphatic amino acids at 288.15, 298.15, 313.15, and 328.15 K. Can. J. Chem. 72: 362–368.

[9] Von Hippelm, P.H, and Schleich. 1969. Ion effects on the solution structure of biological macro-molecules. T. Acc. Chem. Res. 2: 256-257.

[10] Timasheff, and G.D. Fasman. 1969. Structure and stability of Biological Macro Molecules. 2, Marcel dekker: New York, 65: 213.

[11] Banipal, T.S., Damanjit Kaura, P.K. Banipal, and Gagandeep Singha. 2004. Partial molar adiabatic compressibilities and viscosities of some amino acids in aqueous 1,4-dioxane solutions at 298.15 K. Ind. J. Chem. 43(A): 1156-1166.

[12] Wadi, R.K., and R.K., Goyal. 1992. Temperature dependence of apparent molar volumes and viscosity B-coefficients of aminoacids in aqueous potassium thiocynate solutions from 15 to 35ºC. J. Sol. Chem. 21: 163-170.

[13] Thirumaran, S., and K. Job Sabu. 2009. Ultrasonic investigation of amino acids in aqueous sodium acetate medium. Ind. J. Pure Appl. Phys. 47: 87-96.

[14] Palani, R., and S. Saravanan. 2008. Volumetric, compressibility and transport studies of some amino acids in aqueous magnesium acetate at 298.15K. Res. J. Phys. 2: 13-21.

[15] Cowan, J.A. 1995. Biological Chemistry of magnesium. 1st Edn. VcH: New York, ISBN: 978-0-471-18583-3.

[16] Ishwara Bhat and N.S. Shree Vara Prasad. 2004. Study on acoustic nature of succinimide in water+DMSO/DMF and Dioxan at 303K. Ind. J. Pure Appl. Phys. 42: 96-103.

[17] Ragouramane, D. and A. S. Rao. 1998. Ultrasonic studies on the influence of some amino acids on molecular interactions in aqueous solutions of ethanol. Ind. J. Chem. 37A: 659-662.

[18] Dhanalakshmi, A. and E. Jasmine Vasantharani. 1992. Analysis of Apparent molal volume and apparent molal compressibility of quaternary ammonium salt in non-aqueous medium. J. Pure Appl. Ultrason. 21: 79-82.

[19] Prakash, S., F.M. Icchhaporia, and J.N. Pandey. 1964. Structural studies of complex bariam citrate by ultrasonic waves. J. Phys. Chem. 68: 3078-3080.

[20] Banipal, T.S., Damanjit Kaura, P.K. Banipal, and Gagandeep Singha. 2007. Thermodynamic and transport properties of l-serine and l-threonine in aqueous sodium acetate and magnesium acetate solutions at T = 298.15 K. J. Chem. Thermodyn. 39: 371-384.

[21] Palani, R., and Y. Reeginal. 2010. Volumetric, compressibility and transport behavior of some α-amino

acids in water and aqueous glycerine at 303.15K. J Ind. Chem. Soc. 87: 265-270.

[22] Jahagirdhar, D.V., and A.G. Shankarwar. 2000. Studies in Acoustic properties, partial molar volumes, viscocity, B-coefficients of lithium chloride in aqueous medium at five temperatures. Ind. J. Pure Appl. Phys. 38: 645-650.