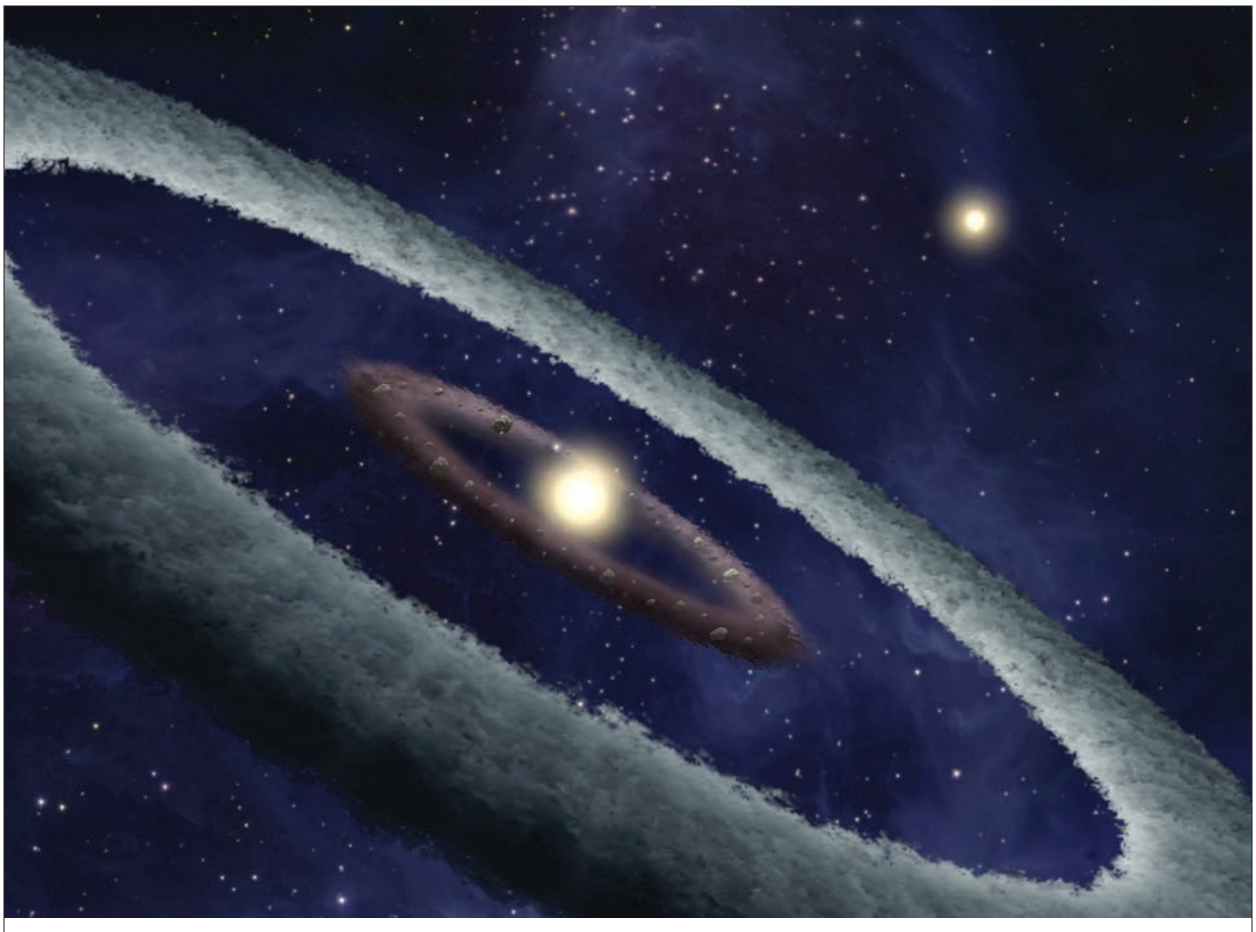

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Volumetric, Compressibility and Transport Studies of Some Amino Acids in Aqueous Magnesium Acetate at 298.15K

[1]R. Palani and [2]S. Saravanan
[1]Department of Physics, D.D.E., Annamalai University, Annamalainagar-608 002, India
[2]Department of Engineering Physics, Annamalai University,
Annamalainagar-608 002, India

Abstract: Density (ρ), viscosity (η) and ultrasonic velocity (U) have been measured for L-glutamine, L-arginine and L-lysine in aqueous magnesium acetate (0, 0.5 and 1 mol kg^{-1}) at 298.15K. These measurements have been performed to evaluate some important parameters viz., adiabatic compressibility (β), molal hydration number (n_H), apparent molal compressibility (φ_K), apparent molal volume (φ_V), limiting apparent molal compressibility (φ^0_K), limiting apparent molal volume (φ^0_V) and their constants (S_K, S_V), transfer adiabatic compressibility ($\Delta \varphi^0_K$), transfer volume ($\Delta \varphi^0_V$) and viscosity A and B-coefficient of Jones-Dole equation. These parameters have been interpreted the molecular interactions in terms of ion-ion and ion-solvent interaction present in the given solutions.

Key words: Amino acids, apparent molal volume, apparent molal compressibility, transfer volume

INTRODUCTION

Salts have marked effects on the stability of protein structures and some electrolytes have a tendency to disrupt some, at least, of the structural features of proteins, where as other electrolytes show propensity to buttress such structures (Von Hippel and Schleich, 1969). The study of the thermodynamic stability of the native structure of proteins has proved quite challenging (Timasheff and Fasman, 1969). Salt solutions have large effects on the structure and properties of proteins including their solubility, denaturation, dissociation into subunits. Amino acids are the fundamental structural units of proteins. 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 study of these model compounds (amino acids) in aqueous salt solution is more significance in understanding the effects of salts on biomolecules. Various workers have studied the interaction between some amino acids and simple salts (Badarayani and Kumar, 2003; Wadi and Goyal, 1992; Banipal *et al*., 2004a; Singh *et al*., 2003), which act as stabilizer/destabilizer, but very few studies are available about the behaviour of amino acids in the presence of organic salts (Yan *et al*., 2001; Wang *et al*., 2004; Banipal *et al*., 2004b). Most of this work on amino acids has been carried out in dilute electrolytes solutions. Although various studies of amino acids are available in the presence of electrolytes having divalent cations (Kumar and Badarayani, 2003), but, no report has been found in the presence of organic salts having divalent cations. Therefore, in order to understand the behaviour of proteins in aqueous salt solutions, we have studied the volumetric, transport and compressibilities for some amino acids in aqueous magnesium acetate solutions at 298.15K. Magnesium acetate has been chosen as organic salt because magnesium found immense importance in biological chemistry (Cowan, 1995). In this study, we report the values of density (ρ), viscosity (η) and ultrasonic

Corresponding Author: R. Palani, Department of Physics, D.D.E., Annamalai University, Annamalainagar-608 002, India

velocity (U) of L-glutamine, L-arginine and L-lysine in aqueous magnesium acetate (0.5 and 1 mol kg^{-1}) at 298.15K. Various parameters like, adiabatic compressibility (β), molal hydration number (n_H), apparent molal compressibility (φ_K), apparent molal volume (φ), $_V$limiting apparent molal compressibility (φ^0_K), limiting apparent molal volume (φ^0_V) and their constants (S_K,S_V), transfer adiabatic compressibility ($\Delta\ \varphi^0_K$), transfer volume ($\Delta\ \varphi^0_V$) and viscosity A and B-coefficient of Jones-Dole equation (Jones and Dole, 1929), respectively were calculated from the density, viscosity and ultrasonic velocity data. All these parameters are discussed in terms of ion-solvent and ion-ion interactions occurring between amino acids and aqueous magnesium acetate solution.

MATERIALS AND METHODS

Analytical reagent (AR) grade and Spectroscopic Reagent (SR) grade with minimum assay of 99.9% of L-glutamine, L-arginine, L-lysine and magnesium acetate were obtained from E-Merck, Germany and SdFine chemicals, India was used as such without further purification. Water used in the experiments was deionised, distilled and degassed prior to making solutions. Solutions of magnesium acetate (0.5 and 1 mol kg^{-1}) were prepared by mass and used on the day they were prepared. Solution of amino acids in the concentration range of 0.02-0.1 mol kg^{-1} were made by mass on the molality concentration scale with a precision of $\pm 1\times10^{-4}$ g on a electronic digital balance (Model: SHIMADZU AX200). The density was determined using a specific gravity bottle by relative measurement method with an accuracy of $\pm$0.01 kg m^{-3}. An Ostwald's Viscometer (10 mL capacity) was used for the viscosity measurement and efflux time was determined using a digital Chronometer to within $\pm$0.01 sec. An ultrasonic interferometer having the frequency 3 MHz (MITTAL ENTERPRISES, NEW DELHI, MODEL F-81) with an overall accuracy of $\pm$0.1% has been used for velocity measurement. An electronically digital operated constant temperature bath (RAAGA Industries) 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 $\pm$0.1K.

Theory and Calculations

Using the measured data, the following volumetric, compressibility and transport parameters have been calculated using the standard relations.

$$\text{Adiabatic compressibility } \beta = \frac{1}{U^2\rho} \tag{1}$$

Molal hydration number has been computed using the relation

$$n_H = \left(\frac{n_1}{n_2}\right)\left(1-\frac{\beta}{\beta_0}\right) \tag{2}$$

where, β and β_0 are adiabatic compressibilities of solution and solvent respectively, n_1 and n_2 are number of moles of solvent and solute, respectively.

The apparent molal compressibility has been calculated from relation,

$$\varphi_K = \frac{1000}{m\rho_0}(\rho_0\beta-\rho\beta_0)+\left(\frac{\beta_0 M}{\rho_0}\right) \tag{3}$$

where, β, ρ and β_0, ρ_0 are the adiabatic compressibility and density of solution and solvent, respectively, m is the molal concentration of the solute and M the molecular mass of the solute. φ_K is the function of m as obtained by Gucker (1933) from Debye Huckel theory and is given by:

$$\varphi_K = \varphi_K^0 + S_K m^{1/2} \tag{4}$$

where, φ^0_K is the limiting apparent molal compressibility at infinite dilution and S_K is a constant. φ^0_K and S_K of equation 4 have been evaluated by the least square method.

The apparent molal volume φ_V has been calculated using the relation:

$$\varphi_V = \left(\frac{M}{\rho}\right) - \frac{1000\ (\rho - \rho_0)}{m\rho\rho_0} \tag{5}$$

The apparent molal volume φ_V has been found to differ with concentration according to empirical relation as:

$$\varphi_V = \varphi_V^0 + S_V m^{1/2} \tag{6}$$

where, φ^0_K is the limiting apparent molal volume at infinite dilution and S_V is a constant and these values were determined by least square method.

Transfer adiabatic compressibility ($\Delta\varphi^0_K$) and transfer volumes ($\Delta\ \varphi^0_V$) of each amino acid from water to aqueous magnesium acetate solutions have been calculated as:

$$\Delta\ \varphi^0_Y = \varphi^0_Y \text{ (in aqueous magnesium acetate solution)} - \varphi^0_Y \text{ (in water)} \tag{7}$$

where, φ^0_Y denotes limiting apparent molal compressibility φ^0_K and limiting apparent molal volume φ^0_V.

The viscosity A and B coefficients for the amino acids in aqueous magnesium acetate solutions were calculated from the Jones-Dole equation (Jones and Dole, 1929; Pandey *et al*., 1987).

$$\frac{\eta}{\eta_0} = 1 + Am^{1/2} + Bm \tag{8}$$

where, η and η_0 are the viscosities of the solution and solvent, respectively and m is the molal concentration of the solute. A is determined by the ionic attraction theory of Falkenhagen-Vernon and therefore also called Falkenhagen coefficient (Pandey *et al*., 1987), B or Jones-Dole coefficient is an empirical constant determined by ion-solvent interactions.

RESULTS AND DISCUSSION

The experimental values of density (ρ), viscosity (η), ultrasonic velocity (U), for different molal composition of each of the three amino acids viz., L-glutamine, L-arginine and L-lysine in water + magnesium acetate mixtures (0, 0.5 and 1 mol kg^{-1}) at 298.15K are shown in Table 1. Further, the values of adiabatic compressibility (β), molal hydration number (n_H), apparent molal compressibility (φ_K), apparent molal volume (φ_V), limiting apparent molal compressibility (φ^0_K), limiting apparent molal volume (φ^0_V) and their constants (S_K,S_V), transfer adiabatic compressibility ($\Delta\ \varphi^0_K$), transfer volume ($\Delta\ \varphi^0_V$) and viscosity A and B-coefficient of Jones-Dole equation are given in Table 2-4.

In all the three amino acids system (Table 1) the values of density and ultrasonic velocity increases with increase in molal concentration of amino acids as well as magnesium acetate content. This increasing trend suggests a moderate strong electrolytic nature in which the solutes (amino acids) tend to attract the solvent (aqueous magnesium acetate) molecules. Molecular association is thus

Table 1: Values of density (ρ) viscosity (η) and ultrasonic velocity (U) of amino acids in aqueous magnesium acetate solutions at 298.15K

	Water + magnesium acetate								
	ρ/ (kg m^{-3})			η/($\times10^{-3}$Ns m^{-2})			U/(m sec^{-1})		
m/(mol. kg^{-1})	0.0 m	0.5 m	1 m	0.0 m	0.5 m	1 m	0.0 m	0.5 m	1 m
System 1: Water + magnesium acetate + L-glutamine									
0.00	997.1	1040.4	1063.3	0.8903	1.3455	1.9041	1502.6	1576.9	1632.6
0.02	999.2	1041.5	1063.8	0.8624	1.3503	1.9085	1512.3	1578.0	1636.2
0.04	1000.3	1042.6	1064.3	0.8802	1.3792	1.9208	1516.7	1580.4	1636.6
0.06	1001.6	1044.0	1066.6	0.8923	1.4133	1.9332	1516.7	1583.2	1637.5
0.08	1002.9	1045.3	1066.7	0.8995	1.4170	1.9575	1523.5	1584.6	1638.2
0.10	1003.6	1046.4	1068.0	0.9061	1.4337	1.9926	1525.9	1584.9	1638.7
System II : Water + magnesium acetate + L-arginine									
0.00	997.1	1040.4	1063.3	0.8903	1.3455	1.9041	1502.6	1576.9	1632.6
0.02	1000.8	1041.6	1063.9	0.8902	1.3618	1.8807	1513.2	1579.0	1637.1
0.04	1001.5	1043.3	1064.7	0.9157	1.3820	1.8956	1518.1	1581.4	1637.8
0.06	1002.6	1044.4	1066.9	0.9274	1.4214	1.9046	1520.3	1584.5	1638.4
0.08	1003.7	1045.8	1067.1	0.9309	1.4289	1.9199	1523.8	1585.3	1639.3
0.10	1004.6	1046.6	1068.6	0.9402	1.5161	1.9256	1526.1	1586.7	1639.9
System III : Water + magnesium acetate + L-lysine									
0.00	997.1	1040.4	1063.3	0.8903	1.3455	1.9041	1502.6	1576.9	1632.6
0.02	1006.8	1041.7	1066.8	0.8907	1.3744	1.9139	1514.1	1580.1	1637.6
0.04	1008.4	1043.8	1068.3	0.9221	1.3924	1.9292	1519.3	1582.6	1638.4
0.06	1008.9	1044.6	1068.9	0.9322	1.4325	1.9620	1520.9	1585.0	1639.3
0.08	1011.2	1046.1	1069.1	0.9383	1.4392	2.0047	1524.9	1586.9	1642.6
0.10	1011.6	1047.2	1070.6	0.9482	1.5287	2.0184	1527.0	1589.1	1644.3

Table 2: Values of adiabatic compressibility (β) and hydration number (n_H) of amino acids in aqueous magnesium acetate solutions at 298.15K

	Water + magnesium acetate					
	β/($\times10^{-10}$ m^2 N^{-1})			(n_H)		
m/(mol. kg^{-1})	0.0 m	0.5 m	1 m	0.0 m	0.5 m	1 m
System 1: Water + magnesium acetate + L-glutamine						
0.00	4.4419	3.8657	3.5284	...	...	...
0.02	4.3759	3.8559	3.5113	5.07	14.34	46.78
0.04	4.3458	3.8402	3.5079	3.65	19.01	52.29
0.06	4.3225	3.8214	3.4965	3.07	22.24	42.92
0.08	4.2959	3.8099	3.4932	3.82	21.01	35.48
0.10	4.2794	3.8045	3.4868	2.50	18.45	33.53
System II : Water + magnesium acetate + L-arginine						
0.00	4.4419	3.8657	3.5284	...	...	...
0.02	4.3637	3.8506	3.5071	5.05	22.91	58.60
0.04	4.3326	3.8327	3.5015	3.54	25.01	37.12
0.06	4.3153	3.8137	3.4917	2.72	26.28	33.72
0.08	4.2908	3.8048	3.4872	2.45	23.09	28.39
0.10	4.2766	3.7952	3.4798	2.14	21.42	26.77
System III : Water + magnesium acetate + L-lysine						
0.00	4.4419	3.8657	3.5284	...	...	...
0.02	4.3347	3.8449	3.4954	6.60	31.58	90.46
0.04	4.2962	3.8251	3.4871	4.48	30.77	56.74
0.06	4.2859	3.8106	3.4813	3.27	28.15	43.68
0.08	4.2528	3.7960	3.4667	2.91	26.42	42.39
0.10	4.2395	3.7815	3.4547	2.49	25.54	40.52

responsible for the observed increase in ultrasonic velocity in these mixtures. The factors apparently responsible for such behaviour may be the presence of interactions caused by the proton transfer reactions of amino acids in water + magnesium acetate mixtures. The increase in ultrasonic velocity in these solutions may be attributed to the cohesion brought about by the ionic hydration. It is known

Table 3: Values of apparent molal compressibility (φ_K) and apparent molal volume (φ_V) of amino acids in aqueous magnesium acetate solutions at 298.15K

	Water + magnesium acetate					
	$-\varphi_k/(\times10^{-7}\ m^2N^{-1})$			$-\varphi_v/(\times10^{-3}m^3mol^{-1})$		
m/(mol. kg^{-1})	0.0 m	0.5 m	1 m	0.0 m	0.5 m	1 m
System 1: Water + magnesium acetate + L-glutamine						
0.02	3.7677	0.9555	0.9405	105.24	56.18	48.36
0.04	2.7092	0.9212	0.7148	80.06	50.56	41.25
0.06	2.3248	0.8343	0.5959	74.95	55.09	21.96
0.08	2.1481	0.8319	0.5816	72.35	50.62	37.33
0.10	1.9126	0.6788	0.5722	64.81	54.97	21.95
System II : Water + magnesium acetate + L-arginine						
0.02	4.7366	1.1160	1.1695	185.22	66.63	52.73
0.04	3.2250	1.0968	0.7919	109.98	55.19	30.75
0.06	2.5200	1.0133	0.8126	91.52	61.19	26.35
0.08	2.2575	0.9829	0.6737	82.28	61.87	41.69
0.10	2.0481	0.9364	0.6629	74.70	56.77	46.48
System III : Water + magnesium acetate + L-lysine						
0.02	7.4097	1.3333	2.2357	458.27	78.09	154.11
0.04	4.9035	1.2865	1.4493	280.78	59.80	109.87
0.06	3.4769	1.1804	1.0957	195.32	64.23	81.95
0.08	3.1495	1.1372	1.0170	174.62	65.29	63.61
0.10	2.6704	1.0953	0.9802	143.57	62.24	63.96

Table 4: Values of limiting apparent molal compressibility (φ^0_K), limiting apparent molal volume (φ^0_V) and their constants S_K and S_V, transfer adiabatic compressibility ($\Delta\ \varphi^0_K$), transfer volumes ($\Delta\ \varphi^0_V$) and A and B coefficients of Jones-Dole equation of amino acids in aqueous magnesium acetate solution at 298.15K

Amino acids	m/(mol kg^{-1})	φ^0_K/ ($\times10^{-7}$ $m^2\ N^{-1}$)	φ^0_V/ ($\times10^{-3}$ $m^3\ mol^{-1}$)	S_K /($\times10^{-8}$ $N^{-1}\ m^{-1}$ mol^{-1})	S_V/ ($\times10^{-3}$ $m^3\ L^{½}$ $mol^{-3/2}$)	$\Delta\varphi^0_K$/ ($\times10^{-7}$ $m^2\ N^{-1}$)	$\Delta\varphi^0_V$/ ($\times10^{-3}$ $m^3\ mol^{-1}$)	A/ ($dm^{3/2}$ $mol^{-1/2}$)	B/ (dm^3 mol^{-1})
L-glutamine	0.0	-4.99	-2007.64	10.19	8133.63	...	...	-0.4029	1.55
	0.5	-0.60	-45.77	1.03	-32.55	4.39	1961.87	-0.0936	1.03
	1.0	-1.11	-37.99	1.82	-128.12	3.88	1969.65	-0.0941	0.71
L-arginine	0.0	-6.54	-253.36	15.23	609.96	...	...	-0.0956	1.35
	0.5	-1.10	28.48	0.29	-134.35	5.45	281.84	-0.1641	0.95
	1.0	-1.46	135.45	2.71	-699.22	5.08	524.26	-0.1746	0.70
L-lysine	0.0	-10.65	-666.61	26.71	1755.23	...	...	-0.0901	1.03
	0.5	-1.51	-68.42	1.29	10.48	9.14	598.19	-0.0726	0.98
	1.0	-3.04	122.29	7.09	-4774.30	7.61	788.90	-0.1115	0.68

that water + magnesium acetate mixtures of L-glutamine, L-arginine and L-lysine contain in addition to the uncharged molecules NH_2CH_2COOH, an electrically neutral molecule, viz., $NH^+{}_3CH_2COO^-$ dipolarions (Zwitterions). When the amino acids are dissolved in water + magnesium acetate mixtures, the cations $NH^+{}_3$ and the anions COO^- are formed. The water molecules are attached to the ions strongly by the electrostatic forces, which introduce a greater cohesion in the solutions. Thus the cohesion increases with the increase of amino acid concentration in the solutions. The increased association, observed in these solutions, may also be due to 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 the volume of solvent, caused by the Zwitterionic portion of the amino acids, is increased in mixed solvents as compared to that in pure water. This effect is similar to the result of Ragouramane and Rao (1998).

From Table 2 it is observed that the values of adiabatic compressibility decreases with increase in molal concentration of amino acids as well as magnesium acetate content in the mixtures. The decrease in adiabatic compressibility, observed in aqueous magnesium acetate mixtures with amino acids in the present study generally confirms that conclusions drawn from the velocity data. The

adiabatic compressibility values are larger in L-glutamine compared to L-arginine and L-lysine which shows molecular association/interaction is greater in L-glutamine than that of other two amino acids. Amino acid molecules in the neutral solution exist in the dipolar form and thus have stronger interaction with the surrounding water molecules. The increasing electrostrictive compression of water around the molecules results in a large decrease in the compressibility of solutions.

The interaction between the solute and water molecules in the solvent is termed hydration. From the Table 2 it is observed that the values of n_H are positive in all systems studied and such positive values of n_H indicate an appreciable solvation of solutes. The values of n_H are found to decrease with increasing the content of solutes, but it increases with increasing the concentration of magnesium acetate in all the three systems studied. The decreasing values of n_H which indicate the increase in solute-co-solute interaction and vice-versa. The increasing behaviour of n_H shows that magnesium acetate has a hydration effect on the amino acids.

The following observations have been made on apparent molal compressibility φ_K and apparent molal volume φ_V (Table 3) of the three amino acids in aqueous magnesium acetate mixtures.

The values of φ_K and φ_V are all negative over the entire range of molality of amino acids and also an increase of magnesium acetate content.

The negative φ_K and φ_V values are increasing with increasing the concentration of amino acids as well as magnesium acetate contents.

The magnitude of φ_K is in order: L-glutamine > L-arginine > L-lysine.

All the observations clearly suggest that the negative values of φ_K and φ_V in all systems indicate the presence of ion-solvent interactions. Further, the negative values of φ_K indicate electrostrictive solvation of ions (Dhanalakshmi and Vasantharani, 1999). The observed increasing behaviour of φ_V suggest the existence of strong ion-solvent interaction in all systems studied. The negative values of φ_K indicate ionic 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 is highly favoured. The increasing values of φ_K of amino acids in aqueous magnesium acetate solution which reveals that the strengthening of ion-solvent interaction in all systems studied. Further, from the magnitude of φ_K, it can be concluded that strong molecular association is found in L-glutamine than other two amino acids and hence L-glutamine is a more effective structure maker.

The limiting apparent molal compressibility φ^0_K provides information regarding ion-solvent interactions and S_K, that of ion-ion interactions in the solution. From Table 4 it is observed that φ^0_K values are negative and it increases with increasing the concentration of magnesium acetate in all systems studied. Appreciable negative values of φ^0_K and its behaviour for all systems reinforce our earlier view that existence of ion-solvent interaction in the mixtures. The magnitude of φ^0_K is in the order: L-glutamine > L-arginine > L-lysine. The values of S_K exhibits positive and it decreases with increasing the concentration of magnesium acetate in all the three amino acids. This behaviour indicates the existence of ion-ion/solute-solute interaction with increase in magnesium acetate content and suggests structure making/breaking effect of the amino acids. It is well known that solutes causing electrostriction lead to decrease in the compressibility of the solution. This is reflected by the negative values of φ_K of the amino acids.

The volume behaviour of a solute at infinite dilution is satisfactorily represented by φ^0_V which is independent of the ion-ion interactions and provides information concerning ion-solvent interactions. Table 4 reveals that the values of φ^0_V are both positive and negative in L-arginine and L-lysine but it found to be negative in L-glutamine mixtures. However, these values are increases with the addition of magnesium acetate contents in all the systems studied. This enhances/reduces the electrostriction of water molecules. Increase in φ^0_V values is due to the reduction in electrostriction at the terminal

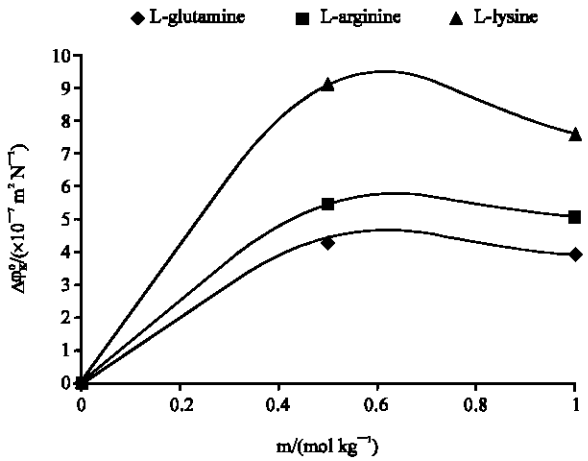

Fig. 1: Transfer adiabatic compressibility ($\Delta\ \varphi^0_K$) of amino acids with molality of aqueous magnesium acetate solutions at 298.15K

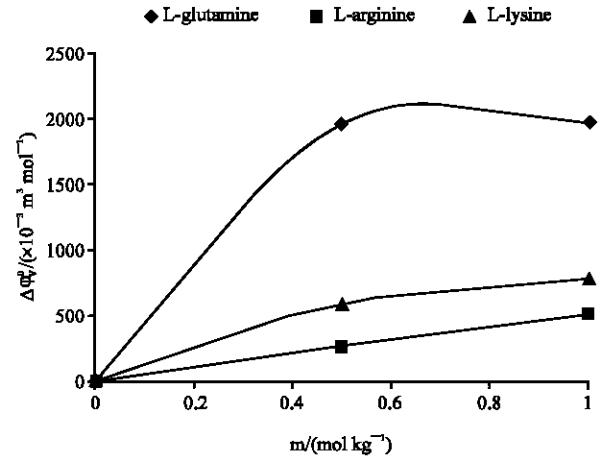

Fig. 2: Transfer volume ($\Delta\ \varphi^0_V$) of amino acids with molality of aqueous magnesium acetate solutions at 298.15K

groups of amino acids, which increases the interaction between these polar ends and ions. The increase in φ^0_V may be attributed to the increased hydrophilicity/polar character of the side chain of the amino acids. The magnitude of φ^0_V is in the order: L-arginine > L-lysine > L-glutamine.

It is evident from the Table 4 that S_V exhibits both negative and positive values in all the systems, suggesting the presence of ion-ion interaction. The positive values of S_V indicate the presence of strong ion-ion interactions and vice-versa. The values of transfer adiabatic compressibility $\Delta\varphi^0_K$ and transfer volume $\Delta\varphi^0_V$ (Table 4) are positive in all systems studied. But, it is observed that the values of $\Delta\varphi^0_K$ are decreases and $\Delta\varphi^0_V$ are increases with increase in the concentration of magnesium acetate in all the three amino acid systems (Fig. 1, 2), which suggest the existence of ion-solvent interactions in the mixtures. Further, the higher magnitude of φ^0_V observed for L-glutamine than for other two amino acids reflects the stronger and more extensive interactions between amino acids and aqueous magnesium acetate mixtures. In the ternary system (amino acids + water + magnesium acetate), the interactions

can be classified into (1) ion-charged group interactions occurring between Mg^{2+} ions and COO^- groups of amino acid and between CH_3COO^- ions of magnesium acetate and NH^+_3 groups of amino acids, (2) ion-non-polar group interactions occurring between ions of magnesium acetate (Mg^{2+}, CH_3COO^-) and non-polar groups of amino acids. According to cosphere overlap model the ion-charged group interactions contribute positively to the $\Delta\varphi^0_K$ and $\Delta\varphi^0_V$ values where as ion-non-polar group interactions contribute negatively. Therefore, the presently observed positive $\Delta\varphi^0_K$ and $\Delta\varphi^0_V$ values for the studied amino acids throughout the concentration range of magnesium acetate indicate that ion-charged group interactions are dominating over the ion-non-polar group interactions. Thus, due to stronger interactions between the ions of magnesium acetate and Zwitterionic centers (NH^+_3, COO^-) of the amino acids, the electrostriction of water molecules lying in the vicinity of these charged centres will be reduced, which give rise to a positive $\Delta\varphi^0_K$ and $\Delta\varphi^0_V$.

From Table 4, it is observed that the values of A are negative and B-coefficient are positive and it decreases with increasing the content of magnesium acetate in all the three amino acids. Since A is a measure of ionic interaction (Jahagirdhar *et al*., 2000) it is evident that there is a weak ion-ion interaction in the amino acids studied, which is indicated by the smaller magnitude of A values. B-coefficient is also known as measure of order or disorder introduced by the solute in to the solvent. It is also a measure of ion-solvent interaction and is directly dependent on the size, shape and charge of the solute molecules. Thus, B values reflect the net structural effects of the solute and solvent molecules. The positive behaviour of B-coefficient in all the amino acids suggest the existence of strong ion-solvent interaction. The magnitude of B values in the order of L-glutamine > L-arginine > L-lysine. This conclusion is in excellent agreement with that drawn from S_V and φ^0_K data and the larger values of B indicate structure making capacity of the solute.

CONCLUSION

In the present research, volumetric, compressibility and transport parameters of L-glutamine, L-arginine and L-lysine in aqueous magnesium acetate solutions at 298.15K were obtained using density, viscosity and ultrasonic velocity data and the results have been used to study the existence of ion-solvent interactions. From the magnitude of φ^0_K and the values of B-coefficient it can be concluded that L-glutamine posses strong ion-solvent interaction than the other two amino acids. The transfer adiabatic compressibility $\Delta\varphi^0_K$ and transfer volume $\Delta\varphi^0_V$ data suggest that ion-charged group interactions are dominating over the ion-non-polar group interactions throughout the magnesium acetate concentrations. Further, the larger $\Delta\varphi^0_K$ values of L-glutamine in aqueous magnesium acetate solutions reveal that stronger interactions occur between magnesium acetate and amino acids which may be due to the smaller size and higher charge density of magnesium cations.

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