Research Article

Thermo - Acoustical Study of Solute-Solvent and Solute-Solute Interactions of Some Amino Acids in Aqueous Potassium Nitrate Solution at 298.15 K

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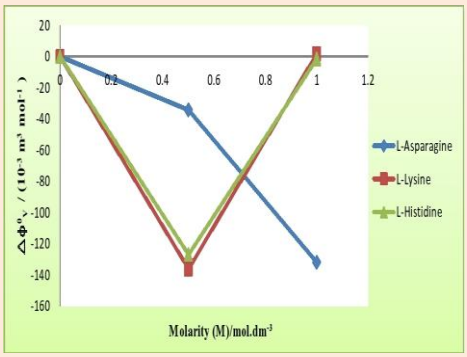
Abstract

The present study exploring about the possible interactions such as solute-solvent and solute-solute present in some amino acids added with aqueous potassium nitrate solution at 298.15K. Experimental values of density, viscosity and speed of sound were carried out on the ternary mixtures of water + potassium nitrate + amino acids namely (L-asparagine, L-lysine and L-histidine) at 298.15K. The binary solvent mixtures was prepared by taking KNO_3 at different molarities (M) by volume, say at 0.0M,0.05M and 1M was added with water. The given amino acids under study were added with aqueous solvent under different molarities at normal atmospheric pressure. The related and relevant parameters related to our present study such as adiabatic compressibility (β),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 their associated constants (S_K, S_V), partial



from transfer volume ($\Delta\varphi_V^0$) water to aqueous solution and viscosity B-Coefficient of Jones-Dole equations were meticulously evaluated. The present study observes strong solute-solvent and solute-solute interactions in L-aspragine system. Our partial transfer volume studies predict the predominance of ion-non-polar hydrophobic group of interactions between the solute-cosolutes.

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Keywords: solute-solvent, solute-solute, ion-polar hydrophobic interaction, viscosity B-Coefficient

Introduction

Ultrasonic velocity studies aqueous solutions of amino acids with electrolytes and non-electrolytes provide useful information in understanding the behavior of liquid systems, intermolecular and intermolecular association, complex formation and related structural changes. For the past two decades, a considerable number of studies have been carried out to investigate hydration of protein through volumetric and ultrasonic velocity measurement [1-3]. Due to the molecular structure of proteins their direct study is what difficult. Therefore, a useful approach is to study simpler

model compounds such as the amino acids that are building blocks of proteins. Most studies on amino acids have been carried out in pure and mixed aqueous solutions [4-5]. Amino acids, the monomer units of protein molecules, play an important role in all living organism. Because amino acids are present as zwitterions in aqueous solutions [6], their volumetric and compressibility properties should reflect structural interactions with water molecules as they do in the electrolytes. Transition metal ions play an important role in plant growth, lipid metabolism and regulation of physiological systems.

The physicochemical properties of amino acids in aqueous solutions provide valuable information on solute-solute and solute-solvent interactions that are important in understanding the stability of proteins, and are implicated in several biochemical and physiological processes in a living cell [7]. Water is chosen for preparing mixed solvent because its presence gives rise to hydrophobic forces [8] which are of prime importance in stabilizing the native globular structure of proteins. The interactions of water with the various functional groups of proteins are important factors in determining the conformational stability of proteins [9]. The stabilization of native conformations of biological macromolecules (proteins) is related to several non-covalent interactions including hydrogen-bonding, electrostatic and hydrophobic interactions [10-11]. These interactions are affected by the surrounding solute and solvent molecules; for this reason, the physicochemical properties of proteins are strongly affected by the presence of these solutes. Because of direct solute-solvent interactions and/or alteration of the water structure, these solutes can change many properties of globular proteins, such as their hydration, solubility and the activity of enzymes [12]. These interactions are important in understanding the stability of proteins, and are implicated in several biochemical and physiological processes in a living cell [13].

Amino acids in aqueous solution are ionized and can act as acids or bases. The amino acid L-asparagine is a structural analog of L-aspartic acid, where the side chain of the carboxylic acid moiety is amidated, to give a terminal amine group. This renders L-asparagine neutral at physiological pH. The amide group of asparagine is derived from glutamate, in the reaction of aspartate and glutamine in the presence of ATP to yield asparagine and glutamate. L-lysine is an essential α-amino acid and a necessary building block for all proteins in the body. As an essential amino acid, L-lysine is not synthesized by humans or animals. Industrially produced L-lysine has therefore a big market as food additive, e.g. in pig food. In the body, L-lysine plays a major role in calcium absorption, building muscle proteins, recovering from surgery or sports injuries, and the body's production of hormones, enzymes, and antibodies. L-Histidine is an essential amino acid important for growth and repair of tissues. It is necessary for the maintenance of myelin sheaths, which protect nerve cells, and potassium nitrate is used as a diuretic in medicine. It also includes as an ingredient in toothpaste. It makes the toothless sensitive to pain. Potassium nitrate affects nucleic acid synthesis in the greening cucumber cotyledons and the stability of tropomyosin [14]. In general the electrolytes present in our body influence the properties of biological molecules like proteins [15-16] which are a vital part of our body.

In the present study, we report the densities (ρ), ultrasonic velocities (U), and viscosities (η) of solutions of amino acids in aqueous potassium nitrate solvents taken at regular intervals, (0.0, 0.5, 1.0 mol dm^{-3}) at 298.15 K and at normal atmospheric pressure. An attempt has been carried out in the light following aspects. Determination of adiabatic compressibility (β), apparent molar compressibility (φ_K), apparent molar volume (φ_V), limiting apparent molar compressibility (φ^0_K), and its related constants (S_K) limiting apparent molar volume(φ^0_V) and its related constants (S_V) and the partial transfer molar volume ($\Delta\varphi^0_v$) from water to aqueous disaccharide solution and to shed more details on the viscometric study, viscosity B-coefficient of Jones- Dole equation and viscosity A-coefficient of Jones- Dole equation has also been evaluated.

Experimental methods

The Amino acids were used after re-crystallization from ethanol–water mixture and dried in vacuum over P_2O_5 at room temperature for 72 h. The aqueous potassium nitrate solution taken in different molarities (M) by volume say, 0.OM, O.5M and 1M was prepared using triple distilled water (conductivity less than $1x10^{-6}$ $S.cm^{-1}$) and these were used as solvents and amino acids was added of six different molar concentrations (ranging from 0 to 0.1 in steps of

0.02). The chemicals were weighed in an electronic digital balance (SHIMADZU AX-200, Japan Make) with a least count of 0.0001g.The density was determined using a 5ml specific gravity bottle by relative measurement method with an accuracy of ±0.01kgm^{-3}.An Ostwald's viscometer of 10ml capacity was used for the viscosity measurement. Efflux time was determined using a digital chronometer within ±0.01s. An Ultrasonic interferometer having the fixed frequency of 2MHz (Mittal Enterprises, New Delhi-Model: F-81) with an overall accuracy of ±0.1ms^{-1}has been used for velocity measurement. An electronically digital operated constant temperature bath (RAAGA industries, Chennai) has been used to circulate water through the double walled measuring cell made up of steel containing the experimental solution at desired temperature, whose accuracy is maintained at 0.1K.

Results and Discussion

In the all three amino acid systems studied, the Table 1 reports about the values of density increase with increase in molar concentration of amino acids (solute) as well as potassium nitrate (solvent) content. The other measured parameter ultrasonic velocity (U) which is also found from (Table 1) to be increased with increase in same concentration of amino acids as well as aqueous solvent content. Such an observed increase in the ultrasonic velocity in these solutions may be attributed to the cohesion brought about by the ionic hydration; which may also be due to the overall increase of cohesion brought about by solute-solute and solute-solvent interaction in solution.

Incidentally, the density (ρ) which is a measure of solute-solvent interactions, which can be attributed as increase of density with concentration indicates the increase in solute-solvent interactions, whereas the decrease in density indicates the lesser magnitude of solute-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. The present study observes an increasing trend of density values may be interpreted to the structure-making behavior of the solvent due to the added solute. [17]

It may be inferred that when amino acids are added with aqueous potassium nitrate solution, the terminal groups of zwitterions of amino acids, $NH_3^+$and COO^- are hydrated in an electrostatic manner whereas, hydration of R group depends on its nature, which may be hydrophilic, hydrophobic or amphiphilic and the overlap of hydration co-spheres of terminal NH_3^+ and COO^- groups and of adjacent groups results in volume change. This may increase due to reduction in the electrostriction at terminals, whereas it decreases due to disruption of side group hydration by that of the charged end [18].

The adiabatic compressibility (β) of the solute can be expressed as the extent to which hydration around the solute molecule can be compressed. The perusal of Table 2 exhibits the values of adiabatic compressibility (β), which are found to be decreased with increase in molar concentration of solute (amino acids) as well as aqueous KNO_3 content (solvent). Such a decrease in adiabatic compressibility observed in solvent (in aqueous KNO_3solution) may be attributed to weakening of hydrogen bond in the solution [19]. It is well known fact that when a solute dissolves in a solvent, some of the solvent molecules are attached to the ions (produced from the solutes), because of ion-solvent interaction. Since, the solvent molecules are oriented in the ionic field these molecules are more compactly packed in the primary salvation shells as compared to the packing in the absence of the ions. This is the reason, why the solvent is compressed by the introduction of the ions. Thus, the electrostatic field of the ions causes the compression of the medium giving rise to a phenomenon called '*Electrostriction'.* Since the water molecules are compressed, they do not respond to a further application of pressure. So the solutions become harder to compress. These will consequently leading to decrease in compressibility values. The apparent molar compressibility (φ_K) of the solute is given by the relation

$$\varphi_K = \frac{1000}{m\rho_0}\left(\rho_0\beta - \rho\beta_0\right) + \left(\frac{\beta_0 M}{\rho_0}\right) \quad (1)$$

in which, m is the molarity of the solution (mol.dm^{-3}),ρ_o is the density of the solvent (kgm^{-3}) and ρ is the density of the solute, β_o and β are the adiabatic compressibility of the solvent and solute, M is the molar mass of the solute (kg.mol^{-1}) respectively.

The apparent molar volume (φ_V) of amino acids has been calculated from the density values of solvent and solution using the relation.

$$\varphi_V = \frac{1000}{m\rho_0}(\rho_0 - \rho) + \left(\frac{M}{\rho_0}\right) \quad (2)$$

Where 'M' is the molarity of the solution (mol.dm^{-3}), M is the molar mass of the solute (kg.mol^{-1}) and, ρ_o and ρ are the density values of the solvent and solution respectively.

The following observations are noticed from Table 2 on apparent molar compressibility (φ_K) and apparent molar volume (φ_V) of amino acids, namely, L-asparagine, L-lysine and L-histidine in aqueous potassium nitrate solution at 298.15K.

Table 1 Values of density (ρ), viscosity (η), and ultrasonic velocity (U) of amino acid in aqueous potassium nitrate Solution at 298.15K

M/ (mol.dm^{-3})	ρ/ (kgm^{-3})			η / (×10^{-3} Nsm^{-2})			U / (m.s^{-1})		
	Water + potassium nitrate								
	0.0M	0.05M	1.0M	0.0M	0.5M	1.0M	0.0M	0.5M	1.0M
System – I : Water + potassium nitrate + L-Asparagine									
0.00	997.13	1013.24	1024.32	0.8910	0.9165	0.9490	1518.24	1523.52	1527.44
0.02	999.34	1016.06	1028.55	0.9149	0.9191	0.9641	1521.84	1525.16	1531.86
0.04	1000.95	1018.28	1030.77	0.9162	0.9322	0.9778	1523.58	1526.64	1533.66
0.06	1001.56	1019.69	1031.17	0.9170	0.9355	0.9839	1525.76	1528.96	1536.08
0.08	1002.97	1020.89	1033.08	0.9285	0.9572	0.9894	1527.45	1529.84	1537.60
0.10	1003.37	1022.10	1035.06	0.9295	0.9696	0.9931	1529.63	1530.96	1538.30
System –II : Water + potassium nitrate + L-Lysine									
0.00	997.13	1013.24	1024.32	0.8910	0.9165	0.9490	1518.24	1523.52	1527.44
0.02	999.74	1017.84	1027.14	0.9040	0.9206	0.9626	1520.24	1525.76	1533.76
0.04	1000.55	1020.48	1029.55	0.9159	0.9454	0.9650	1522.08	1527.36	1536.16
0.06	1002.19	1022.51	1031.97	0.9284	0.9474	0.9894	1524.16	1529.92	1537.84
0.08	1003.17	1025.13	1033.73	0.9294	0.9611	0.9916	1526.64	1531.44	1539.20
0.10	1004.18	1026.34	1035.50	0.9375	0.9745	0.9932	1528.12	1535.20	1540.40
System –III : Water + Potassium Nitrate + L-Histidine									
0.00	997.13	1013.24	1024.32	0.8910	0.9165	0.9490	1518.24	1523.52	1527.44
0.02	1001.76	1019.69	1029.15	0.9282	0.9336	0.9652	1524.56	1528.96	1536.24
0.04	1002.32	1022.31	1031.77	0.9398	0.9472	0.9788	1526.80	1530.80	1538.40
0.06	1003.57	1024.17	1033.02	0.9408	0.9598	0.9801	1528.88	1534.57	1540.08
0.08	1004.98	1025.93	1035.40	0.9644	0.9732	0.9936	1530.96	1535.44	1542.40
0.10	1005.59	1027.54	1037.21	0.9769	0.9860	0.9954	1532.08	1537.60	1545.61

1. The values of the apparent molar compressibility (φ_K) and apparent molar volume (φ_V) are all negative over the entire molarity (M) range of amino acids (solute).
2. The values of apparent molar compressibility (φ_K) as well as apparent molar volume (φ_V) are found to be increased with increasing molarity (M) of solute (amino acids).
3. However, the apparent molar compressibility (φ_K) decreases with elevation of solvent concentration.
4. The present study notices that the apparent molar volume (φ_V) decreases in system-I and the same found to be increased in Systems II & III with elevation of solvent concentration.

The above observations clearly suggesting that the existence of solute-solvent interaction is in the solution. The negative values of apparent molar compressibility indicate the ionic-hydrophilic interactions occurring in these

systems. Since, more number of water molecules are available at lower concentration of aqueous KNO_3, the chances for the penetration of solute molecules in the solvent molecules are highly [20] favored. The decreasing values of apparent molar compressibility with increasing molar concentration of solvent content in aqueous medium reveal the strengthening of the solute-solvent interaction. Further, one could find that the apparent molar volume (φ_V) decreases in system-I and the same found to be increased in System II & III with elevation of solvent concentration suggesting the more inter ionic (solute-solvent) interactions pronounced in system-I comparing other liquid systems.

The values of Limiting apparent molar compressibility (φ^0_K) in the present study, have been fitted by Least-squares method with the equation

$$\varphi_K = \varphi_K^0 + S_K m^{½} \quad (3)$$

Where (φ^0_K) is the limiting apparent molar compressibility at infinite dilution and S_K is its associated constant.

The Limiting apparent molar compressibility (φ^0_K) which is concerned with the solute-solvent interactions and its related constant (S_K) is concerned with that of the solute-solute interactions in the solution, which are systematically tabulated in Table 3. It is noticed that the φ^0_K values are negative in all the three liquid systems and decrease with molar concentration of solvent (aqueous KNO_3 solution). From **figure 1**, the negative values of (φ^0_K) for all the systems and their decreasing trend in the present study suggesting the existence of solute-solvent interactions. The related constant S_K whose values are positive in all the systems and from the **Figure 2** it can be seen an increasing trend of these values with elevation of aqueous potassium nitrate content. Such an increasing trend of positive values of S_K indicates the strengthening of solute-solute interactions in the solution.

Table 2 values of adiabatic compressibility (β),apparent molar compressibility (φ_K) and apparent molar volume (φ_V) of amino acid in aqueous potassium nitrate Solution at 298.15K

M/ (mol.dm^{-3})	β/ (×10^{-10} m^2 N^{-1})			-φ_K / (×10^{-8} m^2 N^{-1})			-φ_V / (×10^{-3} m^3 mol^{-1})		
	Water + potassium nitrate								
	0.0M	0.05M	1.0M	0.0M	0.5M	1.0M	0.0M	0.5M	1.0M
System – I : Water + potassium nitrate + L-Asparagine									
0.00	4.3507.	4.2519	4.1844	-	-	-	-	-	-
0.02	4.3206	4.2310	4.1454	19.8604	16.3604	27.8806	110.6674	139.0092	206.3316
0.04	4.3003	4.2136	4.1244	15.8852	14.6312	21.5788	95.7596	124.2053	157.2447
0.06	4.2889	4.1950	4.1103	13.5138	13.9929	17.0067	74.0306	105.9336	111.4410
0.08	4.2744	4.1853	4.0942	12.7148	12.3303	15.4088	73.0590	94.2268	106.7534
0.10	4.2595	4.1742	4.0829	11.8353	11.4812	14.6288	62.4285	87.2938	104.7026
System –II : Water + potassium nitrate + L-Lysine									
0.00	4.3507	4.2519	4.1844	-	-	-	-	-	-
0.02	4.3289	4.2202	4.1386	16.5864	23.7392	28.6512	130.7108	226.8323	137.4889
0.04	4.3122	4.2006	4.1160	13.4833	20.4133	22.4403	85.5812	178.4726	127.4851
0.06	4.2952	4.1782	4.0974	12.9224	18.7601	19.6843	84.4117	153.2865	124.3122
0.08	4.2771	4.1593	4.0855	12.4106	17.7991	17.1638	75.5521	134.0601	114.7618
0.10	4.2638	4.1274	4.0687	11.6085	16.1066	16.0199	72.5433	129.1257	108.9844
System –III : Water + Potassium Nitrate + L-Histidine									
0.00	4.3507	4.2519	4.1844	-	-	-	-	-	-
0.02	4.2950	4.1950	4.1172	37.9436	41.9726	43.4562	232.0106	318.1324	235.6144
0.04	4.2798	4.1742	4.0952	23.3792	28.9328	29.9099	129.9675	223.6336	181.6762
0.06	4.2629	4.1462	4.0813	19.3094	25.2539	23.5063	107.4864	179.6104	151.1697
0.08	4.2453	4.1344	4.0597	17.4494	21.3370	21.3788	98.2512	156.3983	135.0605
0.10	4.2323	4.1163	4.0383	15.7566	19.5534	19.8687	88.9781	140.9778	125.6872

Table 3 The values of limiting apparent compressibility (φ^0_K),and their constants S_K limiting apparent molar volume (φ^0_V) and their constants S_v of the amino acids in aqueous potassium nitrate solution at 298.15 K

Amino acids	M (mol.dm^{-3})	$-(\varphi^0_k)$ x 10^{-8} m^{2}N^{-1}	S_k (x10^{-8} N^{-1} m^{-1} mol^{l})	$-(\varphi^0_V)$ (X 10^{-3}m^{3}mol^{-1})	S_v (x10^{-3} m^3 L$^{1/2}$ mol$^{3/2}$)
L-Asparagine	0.0	25.5267	45.4079	148.9194	227.2733
	0.5	20.3035	27.6077	183.0717	307.6772
	1.0	41.9015	95.3412	280.9098	605.8180
L – Lysine	0.0	19.6204	26.2323	162.3522	306.1945
	0.5	29.8157	44.0914	298.4726	565.7519
	1.0	37.8098	71.7896	160.3598	159.2565
L-Histidine	0.0	52.1798	124.0725	313.7144	769.3228
	0.5	56.3993	124.3985	440.5836	999.0431
	1.0	60.0534	132.5814	314.9368	628.9348

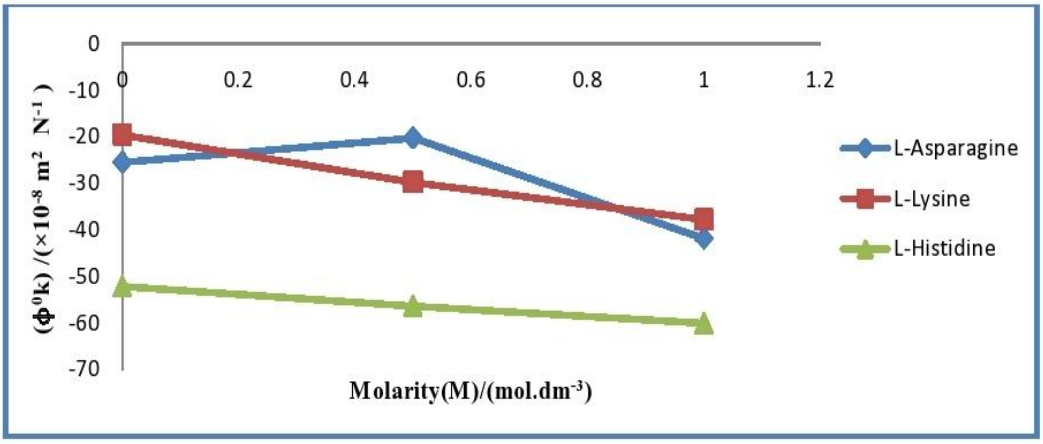

Figure 1 Variation of limiting apparent molar compressibility (φ^0_K) of amino acids with molarity of aqueous KNO_3 solution at 298.15K

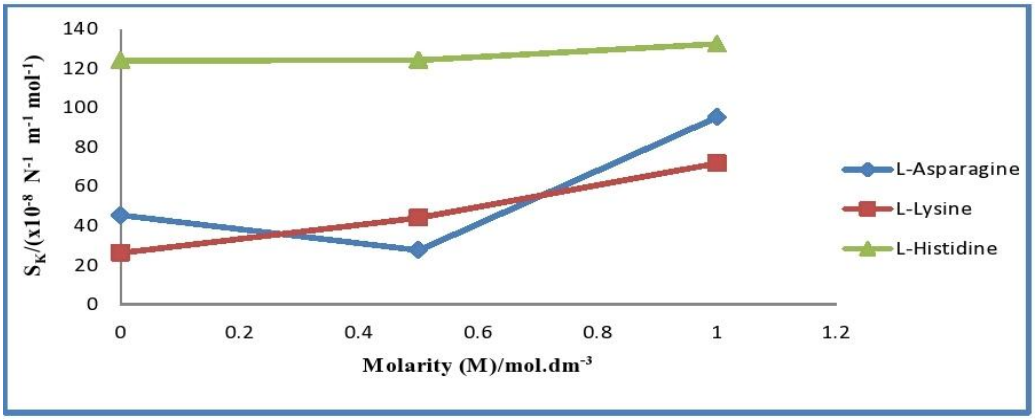

Figure 2 Variation of limiting apparent molar compressibility constant (S_K) of amino acids with molarity of aqueous KNO_3 solution at 298.15K

The limiting apparent molar volume (φ^0_V) in the present study have been fitted by method of Least-squares with the equation

$$\varphi_V = \varphi_V^0 + S_V m^{½} \quad (4)$$

Where $\varphi^0 v$ is the limiting apparent molar volume at dilution and S_V is its associated constant.

The perusal of Table 3 depicts the values of limiting apparent molar volume (φ^0_V) exhibiting negative values in all the systems and decrease in System –I and Figure 3 found to be increased in Systems II & III with the elevation of solvent content. The decreasing trend may be attributed to increased hydrophilicity/polar and ion-non polar hydrophobicity character of the side chain of the amino acids. Such a decreasing trend found in system -I indicating a strong solute-solvent interaction. As seen from the Table 3, the values of S_V are positive in all liquid systems. The perusal of figure 4 observes that S_V values are increasing in system-I and decreasing in Systems II and III with increase of solvent content. The increasing trend of these values suggesting a strong solute-solute interactions are existing in System-I (L-asparagine) comparing other systems [21, 22].

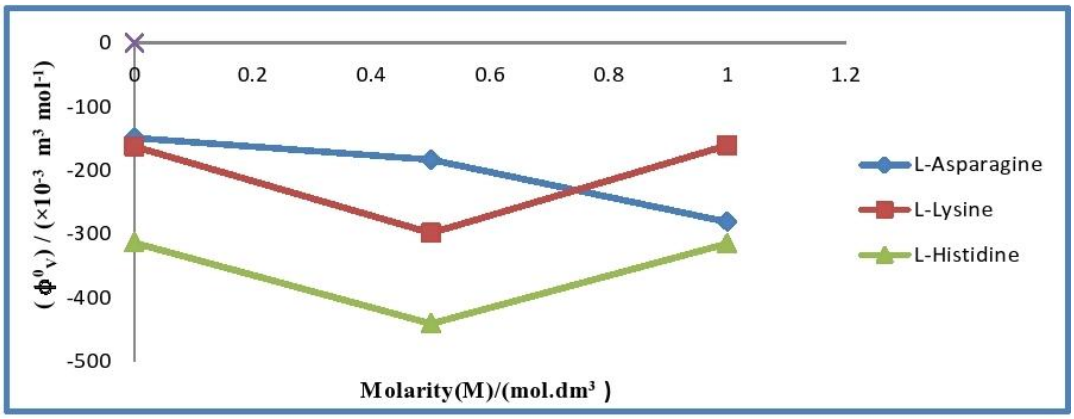

Figure 3 Variation of limiting apparent molar volume (φ^0_V) of amino acids with molarity of aqueous KNO_3 solution at 298.15K

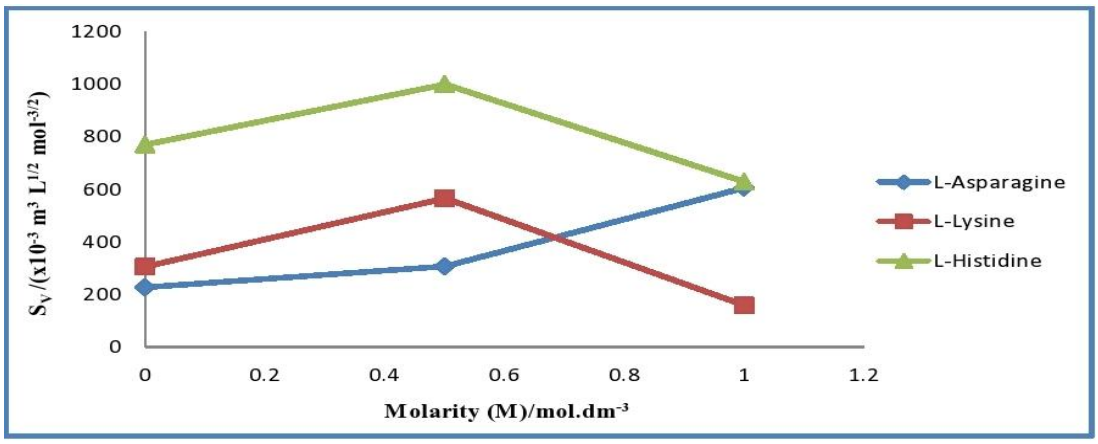

Figure 4 Variation of limiting apparent molar volume constant (S_V) of some amino acids with molarity of aqueous KNO_3 Solution at 298.15K.

Table 4 Partial transfer volume ($\Delta\varphi_V^0$) and A and B co-efficient of Jones-Dole equation of amino acids in aqueous potassium nitrate solution at 298.15 K

Amino acids	M/(mol.dm^{-3})	$\Delta\varphi_V^0$ /(10^{-3} m^3 mol^{-1})	A/(dm$^{3/2}$.mol$^{-1/2}$)	B/(dm$^{3/2}$.mol^{-1})
L-Asparagine	0.0	-	0.1299	0.0972
	0.5	0.0341	0.1003	0.0951
	1.0	0.1319	0.1356	0.1106
L –Lysine	0.0	-	0.1392	0.1164
	0.5	0.1361	0.1326	0.1196
	1.0	0.0019	0.1266	0.1073
L-Histidine	0.0	-	0.2659	0.2120
	0.5	0.1268	0.1809	0.1542
	1.0	0.0012	0.1395	0.1141

The Partial molar transfer volume ($\Delta\varphi_V^0$), of amino acids from water to aqueous KNO_3 solution at a given temperature quoted as.

$$\Delta\varphi_V^0 = \varphi_V^0 \text{ (in aqueous solution)} - \varphi_V^0 \text{ (in water)}$$

Where, $\Delta\varphi_V^0$ denotes the transfer volume

The present investigation observes the partial transfer volume ($\Delta\varphi^0_V$) study dealing about the interactions between the solute-cosolute exhibits a negative deviations in all the three liquid systems and in the present study it decrease with elevation of aqueous KNO_3 content in System-I and the same shows a reverse trend in systems II and III. Generally, the interaction between amino acids and potassium nitrate may be presumed as,

1. Ion-ion interaction among the K^+ and NO_3^- ions and (COO-, NH_3^+) zwitterionic groups,
2. Ion-hydrophilic interactions between ions and hydrophilic groups (-$CONH_2$, -CONH) of amino acids, and
3. Ion-non-polar group interaction occurring between ions and the non-polar groups (-CH_2/-CH_3) of amino acids [23].

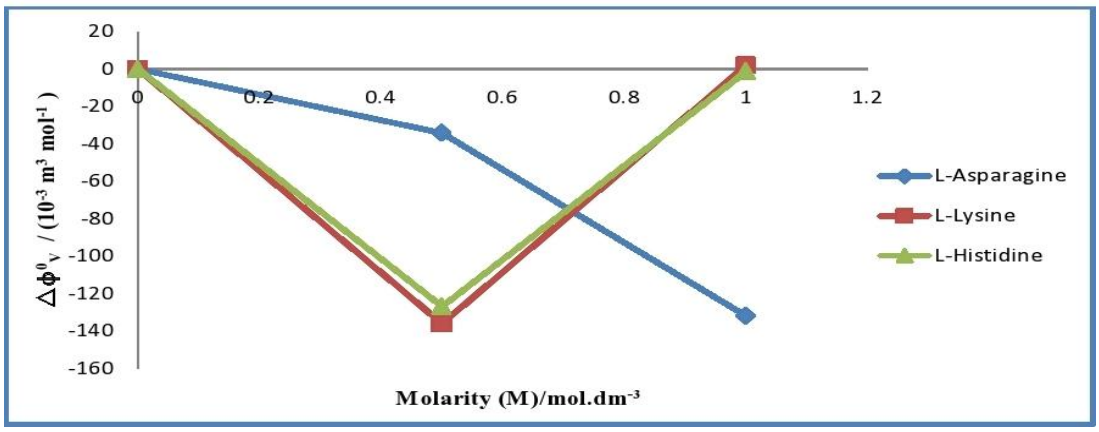

Figure 5 Variation of the partial transfer molar volume ($\Delta\varphi^0_V$) of amino acids with molarity of aqueous KNO_3 solution at 298.15K.

The partial transfer volume (($\Delta\varphi^0_V$) can be explained on the basis of Co-Sphere overlap Model [24] According to this model, ion-ion and ion-hydrophilic group interactions contribute positively, whereas, ion-non-polar group interactions contribute negatively to the partial transfer volume ($\Delta\varphi^0_V$) values. Therefore, from figure 5 the negative($\Delta\varphi^0_V$) values observed in all the three amino acid systems suggest that the interaction contribution of type (iii) is much stronger than the type (i) and (ii) interactions. The decreasing values of ($\Delta\varphi^0_V$) in system -I advocates the existence strong interaction between the solute co-solute. Hence it is very obvious that in L-asparagine (System-I), a strong solute-cosolute interactions are noticed comparing the other amino acid systems.

We have also incorporated the viscometric study by employing the Jones-Dole equation [25].

$$\eta/\eta_o = 1=Am^{1/2}+Bm \quad (5)$$

Where η and η_o are the viscosities of the solution and solvent respectively, m is the molar concentration ($mol.dm^{-3}$) of the solute. A and B are constants which predict for a solute-solvent system. A is known as the Falkenhagen co-efficient which characteristics the ionic (solute-solute) interaction in the solution and B is the Jones-Dole (or) viscosity B co-efficient, which depends on the size of the solute and the nature of the solute-solvent interactions.

Viscosity is one of the key transport properties of the solutions. Accurate viscosity data give useful information regarding ion-solvent interactions (long-range electrostatic interaction), which are the controlling force in dilute solutions. Viscosity data are necessary to calculate the physical parameters of Jones-Dole equation, which apply to analyze the experimental data [25, 26]. In the present study, the values of B for all studied system are positive and the positive values of the B co-efficient is attributed with structure making (ordering) ions. Our present study finds that the viscosity B co-efficient values are increasing in System-I and decrease in Systems II & III with increase of molar concentration of aqueous solvent (KNO_3) content. It is obvious that the increasing positive values of B in this system clearly attribute the dominance of solute-solvent interactions comparing the other three liquid systems. Hence, it is very obvious that System-I possesses a very strong solute-solvent interactions. For identifying the ion-ion interactions existing in the mixture, which is reflected by the values of A in the present investigation are all positive and increase in System-I and decrease in Systems II & III with increase of solvent content. From Table 4, which clearly depicts the strong ion-ion interactions are found in System-I and weakening of the same in Systems II and III. Hence, it is very obvious that a strong solute-solvent, and solute-solute interactions are more dominant in System-I (L-asparagine system). This is in well agreement with our earlier conclusion drawn from the other parameter.

Conclusions

The present investigation probing the acoustical behavior of amino acids namely, L-asparagine, L-Lysine and L-histidine in aqueous potassium nitrate at 298.15K have been summarized as,

1. It is obvious that a very strong solute-solvent and solute-solute interactions are more pronounced in L-asparagine (system-I) comparing the other amino acid systems.
2. The further addition of solvent (aqueous potassium nitrate solution) enhances a strong molecular interionic interactions such as solute-solute, and solute-solvent in system-I, whereas, it weakens the same in other liquid systems.
3. Our viscometry study also lends another fine support about the existence of strong solute-solvent and ion-ion interactions in the solution.
4. The trends of partial transfer volume studies predicting the dominance of ion-non-polar or ion-hydrophobicity group of interactions in the mixture.

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