STUDY OF THERMODYNAMIC PARAMETERS OF AMINO ACIDS AT 287K & 292K BY VISCOSITY MEASUREMENT.

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A B S T R A C T

The thermodynamic parameters viz. Gibbs Free energy (ΔG), Enthalpy (ΔH) and Entropy (ΔS) of two Amino Acids i.e Methionine and Alanine were calculated by viscometric technique in different concentrations at specific temperature T= 287K and 292K. The solute was taken in 100% of aqueous medium. The density and viscosity data are utilized to obtain specific viscosity and relative viscosity of different concentrations. Jones-Dole equation for viscosity is used to calculate α and β coefficients, of which coefficients interpret solute-solute interactions and solute-solvent interactions respectively. The experimental data gives the idea of the effect of temperatures on molecular interactions in Amino Acids and aqueous medium.

Keywords: Viscosity, Density, thermodynamic parameters, solubility , Amino acids , solute-solute interactions etc.

INTRODUCTION

Amino Acids are a group of organic compounds containing two functional group amino (NH2) and carboxyl (-COOH). The amino group is basic while the carboxyl group is acidic in nature .There are 20 amino acids of which 11 are non-essential amino acids and 9 are essential amino acids .The non-essential amino acids are which your body can build from chemicals already present in your body. The essential amino acids are those which get from diet or you have to eat proteins that contain those amino acids .The general reactions in amino acids occur due to presence of two functional amino(NH2) and carboxyl (-COOH) group.

The Amino Acids Methionine and Alanine have Antioxidants and Anti-Diabetic properties. The Methionine and Alanine are water soluble. The methionine encourages Angiogenesis while Alanine is incorporated into proteins. The Structural Formula for Methionine and Alanine are respectively.

Methionine
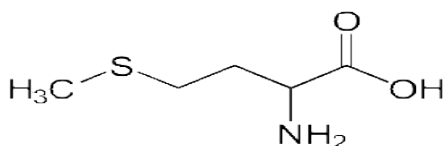
L-Alanine
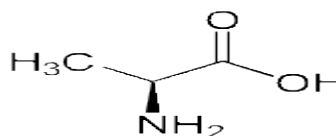
Sulphur content of Methionine, initiate the growth in tissues and reduces depositing fat in the liver. And L-Alanine is used for low blood sugar concentration & converts amino acids into Glucose [

1].When amino acids are joined together in proteins, only their side chains (also called

radicals or residues) are left free to interact with each other and molecules of their surrounding medium (water or lipids). These side chains, therefore, have a strong influence on how the protein behaves in water[2]. Hydrogen bonds are really a form of electrostatic charge, but weaker than the charges on most ions[3].

Viscosity is a measure of resistant to flow under an applied stress, express as shear stress divided by shear rate[4]. Ostwald Viscometer are instrument used to measure the viscosity. Viscometry method is used to calculate relative viscosity, Instrinsic viscosity[5].

The present work of viscometric study of amino acid was carried out at different temperature by preparing the solutions of different concentrations of Methionine and L-Alanine. The solutions of above mentioned amino acid were prepared in the 100% Water at different temperature (287K, 292±0.1K) and different concentration.

MATERIALS AND METHODS:

The Amino Acids Methionine & L-Alanine are made sure to be in its pure form. The solutions grades of both were freshly prepared in 100% aqueous medium. Ostwald viscometer was clean with mixture of nitric, chromic acid or ethanol and then wash with water. Dry the viscometer and find out flow time of solutions from upper mark to lower mark . In one arm of the U is a vertical section of precise narrow bore (the capillary). Above there is a bulb, with it is another bulb lower down on the other arm. In use, liquid is drawn into the upper bulb by suction, then allowed to flow down through the capillary into the lower bulb. Two marks (one above and one below the upper bulb) indicate a known volume. The time taken for the level of the liquid to pass between these marks is proportional to the kinematic viscosity. Then each diluted solution was taken in viscometer and the flow time was observed 2 to 3 times[ ]. This procedure was repeated for every dilution and from this viscosity was calculated. And similar procedure was repeated for different

temperature. The densities of the solutions were measured at different temperatures by using density bottle .The flow time of solutions were measured by digital clock.

To determine the relative and specific viscosity, the different concentration of the amino acid solution were prepared and there viscosities are measured with help of the following mathematical relation.

$$(\eta r) = (ds \times ts / dw \times tw) \times \eta w \dots\dots\dots(1)$$

Where

ŋr	-	Relative viscosity
ŋw	-	Viscosity of water
ds	-	Density of solution
dw	-	Density of water
ts	-	Flow time for solution
tw	-	Flow time for water

From the calculated values of relative viscosities (ŋr) and the temperature (T), the graph betweenlog (ŋr) vs 1/T can be plotted. The relative viscosities of solutions at different concentration and at two different temperature are presented in table 1-4. The viscosity data have been analyzed by Jones–Dole equation[ ].

$$(\eta r - 1) / \sqrt{C} = \eta sp / \sqrt{C} = A + B \sqrt{C} \quad \dots\dots(2)$$

Where

A	-	Falkenhagen coefficient
B	-	Jones-Dole coefficient
C	-	Concentration of solutions

The Falkenhagen coefficient (α) measures the solute-solute interation while Jones-Dole coefficient (β) measures the solute-solvent interaction. Value of α and β at two different temperature are represented in Table 5 for Methionine and Alanine respectively.

The values of viscosity of amino acid (Methionine, Alanine) in aqueous medium at different temperature and related parameters such as Gibb's free energy(ΔG) , enthalpy(ΔH),

entropy(ΔS) etc. have been calculated and mentioned in Table 6,7 &8.[8][9]

1. Free energy change (ΔG) -

$$\Delta G = -2.303 \times R \times slope \quad ....(3)$$

2. Enthalpy change (ΔH) –

$$\log ŋr_1 - \log ŋr_2 = (\Delta H/2.303) \times (1/T_1 - 1/T_2)......(4)$$

3. Entropy change (ΔS) -

$$\Delta S = (\Delta G - \Delta H)/T \quad …..................(5)$$

Table 1 .System – Methionine

				Temp: **287** ±0.1K					Medium – water	

Conc.(C) Mole/lit	√C Mole$^{-1/2}$ lit$^{-1/2}$	Density gm/cc	Time Flow (Sec)	Relative Viscosity $ŋ_r = ŋ/ŋ_0$	Specific Viscosity $ŋ_{sp} = ŋ_r - 1$	$ŋ_{sp}/√C$
0.01	0.1	1.001	63	1.2107	0.2107	2.1076
0.005	0.0707	1.0009	62	1.1915	0.1915	2.7082
0.0025	0.05	1.0006	61	1.1719	0.1719	3.4381
0.00125	0.0353	1.0002	59	1.1329	0.1329	3.7614

Table 2 .System-Alanine

Temp: **287** ±0.1K   Medium: Water

Conc.(C) Mole/lit	√C Mole$^{-1/2}$ lit$^{-1/2}$	Density gm/cc	Time Flow (Sec)	Relative Viscosity $ŋ_r = ŋ/ŋ_0$	Specific Viscosity $ŋ_{sp} = ŋ_r - 1$	$ŋ_{sp}/√C$
0.01	0.1	0.99816	66	1.2648	0.2648	2.6482
0.005	0.0707	0.99812	65	1.2456	0.2456	3.4734
0.0025	0.05	0.99768	64	1.2259	0.2259	4.5181
0.00125	0.0353	0.99760	62	1.1875	0.1875	5.3033

Table 3 .System – Methionine

Temp: **292** ±0.1K   Medium: Water

Conc.(C) Mole/lit	√C Mole$^{-1/2}$ lit$^{-1/2}$	Density gm/cc	Time Flow (Sec)	Relative Viscosity $ŋr = ŋ/ŋ_0$	Specific Viscosity $ŋsp = ŋr - 1$	$ŋsp/√C$
0.01	0.1	1.00712	56	1.1045	0.1045	1.0455

0.005	0.0707	1.00704	55	1.0847	0.0847	1.1985
0.0025	0.05	1.007	53	1.0634	0.0634	1.2681
0.00125	0.0353	1.00692	51	1.0475	0.0475	1.3447

Table 4 . System-Alanine

Temp: 292 ±0.1K				Medium : Water		
Conc. (C) Mole/lit	$\sqrt{C}$ Mole$^{-1/2}$ lit$^{-1/2}$	Density gm/cc	Time Flow (Sec)	Relative Viscosity $\eta r = \eta/\eta 0$	Specific Viscosity $\eta sp = \eta r-1$	$\eta sp/\sqrt{C}$
0.01	0.1	1.00736	59	1.05432	0.05432	0.5432
0.005	0.0707	1.00728	58	1.09092	0.09092	1.2858
0.0025	0.05	1.0072	55	1.08492	0.08492	1.6984
0.00125	0.0353	1.00712	54	1.06905	0.06905	1.9531

Table 5. α and β Coefficient values of methionine

	Methionine		Alanine	
Temperature in K	α	β	α	β
287	4.688	-26.31	6.613	-41.05
292	1.504	-4.523	2.772	-21.9

fig.1 plot of √C vs nsp/√C of methionine at 287K

fig.2 plot of √C vs nsp/√C of alanine at 287K

fig.3 plot of √C vs nsp/√C of methionine at 292K

fig.4 plot of √C vs nsp/√C of alanine at 292K
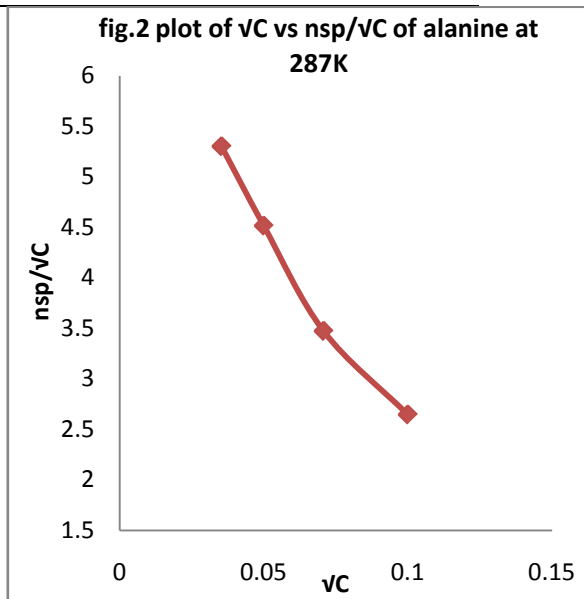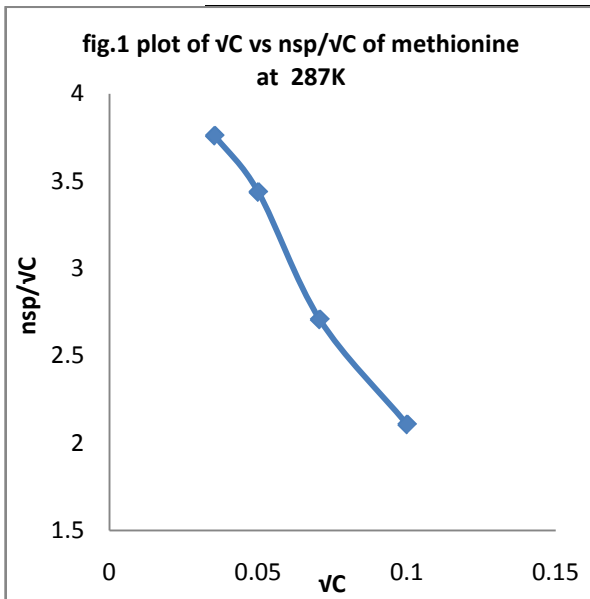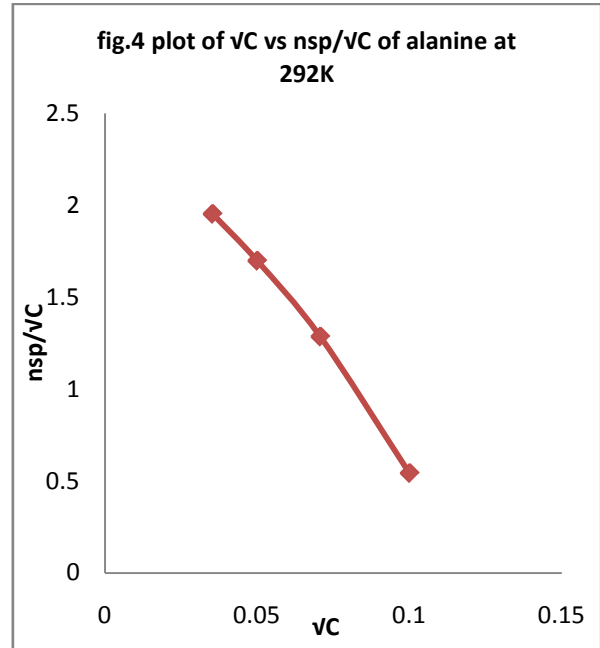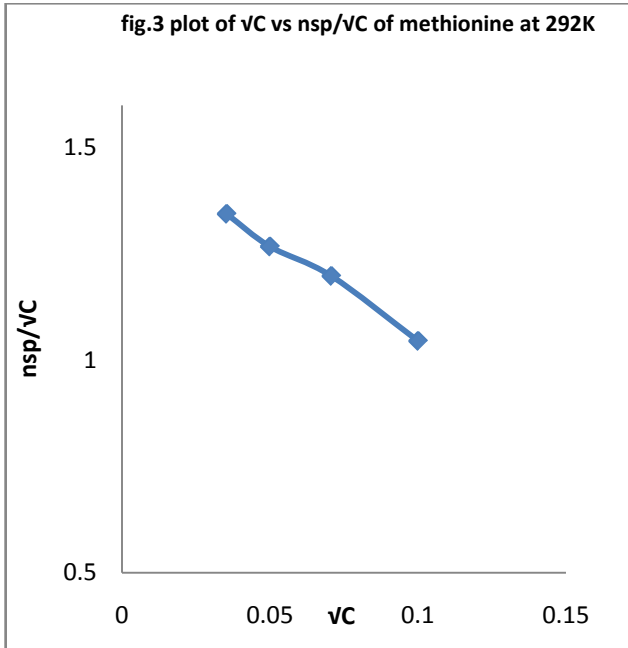
Table 6. System for 0.01M   Methionine

Temp (K)	1/T	Density (Kgm^{-3})	TimeFlow (Sec)	Relative Viscosity (η_r)	Log η_r
287	0.003484	1.007	63	1.2107	0.0830
292	0.003425	1.001	56	1.1045	0.0431

Table 7. System for 0.01M Alanine

Temp (°K)	1/T	Density (Kgm^{-3})	TimeFlow (Sec)	Relative Viscosity (ηr)	Log ηr
287	0.003484	1.007	66	1.2648	0.1020
292	0.003425	0.998	59	1.0543	0.0229

fig.5 plot of log nr vs 1/T 0.01M Methionine

fig.6 plot of log nr vs 1/T 0.01M Alanine
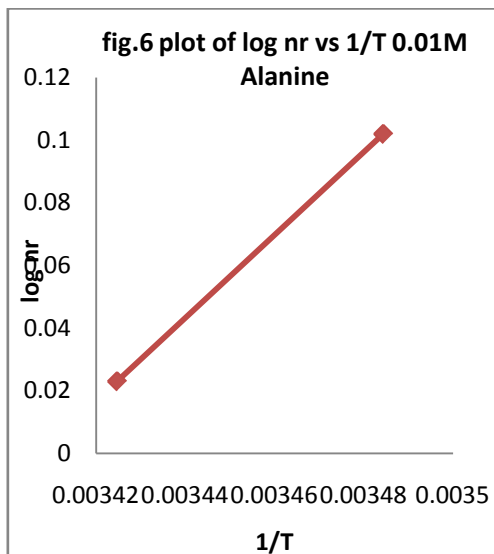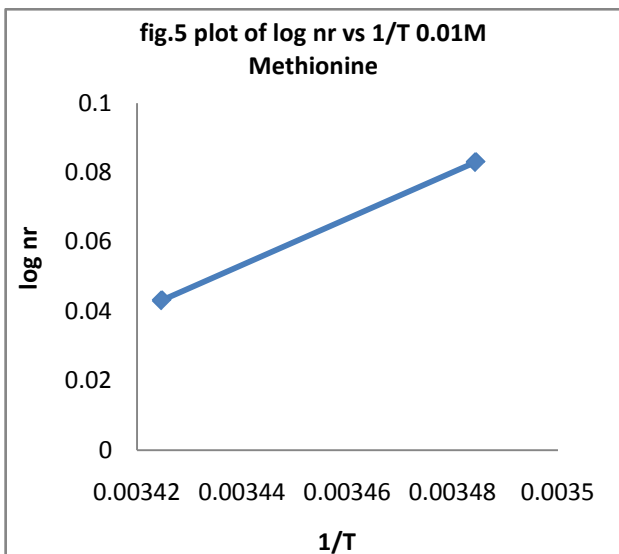
Table 8.

Values of Thermodynamic Parameters for temperature difference 287K –292K

System	ΔG (J mol^{-1} K^{-1})	ΔH (J mol^{-1} K^{-1})	ΔS (J mol^{-1} K^{-1})
0.01M Methionine	-12794.1	-12795.4	0.2618
0.01M Alanine	-25370	-25371.3	0.2773

RESULT AND DISCUSSION

In the present investigation, the relative viscosity of solution of amino acids in aqueous medium increases with increase in concentration of solutions. The increase in viscosity with increase in concentration, may be described to the increase in the interactions of solute-solvent. The large and small deviations in the values of 'α' give us an idea about the stronger and weaker solute-solvent interaction respectively as shown in table 5. The increase in relative viscosity of solutions with concentration measures the increase in interaction of solute and solvent.

The relation between viscosity ($\eta sp/\sqrt{C}$) and concentration of solution ($\sqrt{C}$) represented by plotting the graph (fig. 1-4) These plotted graphs prove the validity of Jones-Dole equation for all systems by giving linear straight line. The values of Jones-Dole coefficients especially β- coefficients are the slope of graph ($\eta sp/\sqrt{C}$) Vs ($\sqrt{C}$) while the values of Falkenhagen coefficient i.e. α - Coefficient are the intercept of graph of ($\eta sp/\sqrt{C}$) Vs ($\sqrt{C}$). T

The order or disorder introduced by solute in solvent is measured by the values of β coefficient which shows either positive or negative values. In this work, the values of β- coefficients for all systems are negative. β-coefficient is found to be negative for all system and is measure the effective thermodynamic volume of solute which accounts for solute-solvent interaction. Summer et al. have shown that the solute with negative β-coefficient[10], it is characterized as 'surface breaker',

signifying weak solute-solvent interactions for all systems. The values of Falkenhagen coefficient (α-coefficient) are positive in all systems shows that there is strong solute-solute interaction in solute molecules in all systems.

Viscosity of the liquid is markedly decreases with the increase in temperature. This is because before a molecule can take part in liquid flow must acquire sufficient energy to push aside the molecules surrounding it. As the temperature increases the number of surrounding molecules increases in proportion to the Boltzmann factor, therefore viscosity may be expected to decrease.

As the temperature increases the value of relative viscosity and density decreases shown in table 5 & 6. Due to increase in temperature the interaction between solute-solute and solute-solvent decreases.

The themodynamic parameter such as free energy change(ΔG), enthalpy change(ΔH) and Entropy Change (ΔS) of two different amino acids are calculated by plotting graph between 1/T Vrs log ɳr are shown In fig 5-6.

Thermodynamic parameter mentioned in table 8. The negative value (ΔG) interpreted that reaction of amino acids and water solvent are spontaneous and feasible i.e. they interact with each other due to the presence of polar groups. The negative value (ΔH) interpreted reaction is exothermic i.e. for solubility of amino acids in water they release more hydration energy than lattice energy. And positive value of(ΔS)

interpreted that, randomness of solute molecule in solvent increases which leads interaction towards stability.

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