I J R B A T, Issue (XI) Vol (II) May 2023 : 267-270

A Double-Blind Peer Reviewed & Refereed Journal

e-ISSN 2347 – 517X

Original Article

INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY

ULTRASONIC STUDY OF ANTIBIOTIC AMPICILLIN SODIUM AT DIFFERENT CONCENTRATIONS

Rajesh S. Hajare

Nilkanthrao Shinde College, Bhadrawati, Dist. Chandrapur, Maharashtra.
Corresponding Email: rajeshhajare34@yahoo.com

Communicated : 20.01.2023 | Revision : 22.02.2023 & 07.03.2023 Accepted : 29.03.2023 | Published : 30.05.2023

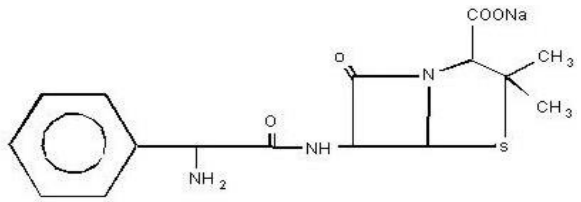
ABSTRACT:

Measurement of ultrasonic velocity and its related properties in the liquid mixture play an important role to study physic-chemical behavior of the solution. Acoustic and thermodynamic properties determine from ultrasonic velocity and related properties which provide qualitative information about molecular interactions in liquid mixture. Ultrasonic velocity, density and viscosity of ampicillin sodium were measured at different concentration at 303.15 temperatures and at 2MHz frequency. From data thermodynamic parameters such as adiabatic compressibility, intermolecular free length, specific acoustic impedance, relative association, relaxation time, Rao's constant and Wada's constant were evaluated. The effect of concentrations on molecular interaction in aqueous solution of ampicillin sodium was interpreted in terms of thermodynamic parameters.

Keywords :- Ultrasonic velocity, Acoustic properties, molecular interaction, Ampicillin sodium.

INTRODUCTION :

Study of ultrasonic velocity is more important in understanding of behavior of binding forces among component of solution. Ultrasonic velocity determines some useful acoustic and thermodynamic properties which give quantitative information about molecular interaction in solution [1-3].These data are particularly important in pharmaceutical industries. A number of researchers[4-14] has investigated molecular interaction in aqueous solution of different antibiotics. Ampicillin sodium is used as an antibiotic in pharmaceuticals.



Ampicillin sodium

In the present investigation, ultrasonic velocity, density and viscosity measurement of aqueous solution of antibiotic ampicillin sodium carried out at different molar concentration at temperature 303.15K, and frequency 2MHz. From the data various acoustic and thermodynamic parameter determine which interpreted molecular interaction in aqueous solution of ampicillin sodium.

Experimental:

Antibiotic drug ampicillin sodium obtained from Aristo Pharmaceuticals Private Limited was used. Double distilled water was used for making solutions. Densities were measured with the help of density bottle. Weighing was done on Roy CCB-4 Balance, (± 0.001 g). A special thermostatic water bath arrangement was made for density, viscosity and ultrasonic velocity measurements in which there is continuous stirring of water with the help of electric stirrer and temperature variation was maintained within ± 0.1°C. All the ultrasonic velocities were measured by single crystal interferometer (Mittal Enterprises, Model F-81) with accuracy of ±

http://doi.org/10.29369/ijrbat.2023.02.1.0038

e-ISSN 2347 – 517X
Original Article

0.03% and frequency 2 MHz. The densities, viscosities and ultrasonic velocities of solvent water and and solutions of ampicillin sodium of concentrations 0.1 M, 0.01 M and0.001 M were measured at temperature 303.15K.

Results and Discussion:

In the present investigation, measurements of densities, viscosities and ultrasonic velocities of solvent water and an antibiotic ampicillin sodium solution have been made and given in Table- 1.

The adiabatic compressibility (β) is evaluated by using equation.

$$\beta = 1 / v^2.d \qquad \text{... ... (1)}$$

Specific acoustic impedance is determined from the measurement of ultrasonic velocity and density by formula,

$$Z = v_s \,.\, d_s \qquad \text{... (2)}$$

Relative association is a function of ultrasonic velocity and is calculated by the equation,

$$R_A = \frac{d_s}{d_0}\left(\frac{v_0}{v_s}\right)^{1/3} \qquad \text{------- (3)}$$

Where, v_0 and v_s are ultrasonic velocities in solvent and solution.

Intermolecular free length has been evaluated from adiabatic compressibility (β) by Jacobson's formula,

$$L_f = K\sqrt{\beta_s} \qquad \text{... ... (4)}$$

Where, K is the temperature dependent constant known as Jacobson's constant and is independent of the nature of liquid. (at 303.15 K, K=631)

Relaxation time is evaluated by equation

$$\tau = 4/3\beta.\eta \qquad \text{.................. (5)}$$

Where, β=adiabatic compressibility **η** =viscosity of experimental liquid

Free volume is calculated by following equation

$$V_f = [M_{eff} v / K\eta]^{3/2} \qquad \text{.......(6)}$$

Where, M_{eff} is effective molecular weight, K is a temperature independent constant which is equal to 4.28×10^9 for all liquids.

Rao's constant is calculated by using following equation.

$$R = [M_{eff}/d_s] v^{1/3} \qquad \text{...... (7)}$$

Wada's constant is calculated by following equation.

$$W = [M_{eff}/d_s]\, \beta^{-1/7} \qquad \text{...... (8)}$$

Relative Viscosity of Solution is calculated by equation

$$\eta_2 = \eta_1.t_2.d_s / t_1.d_0 \qquad \text{. .... (9)}$$

Where, η_2= viscosity of experimental liquid, η_1=viscosity of water, t_1=time flow of water, t_2=time flow of experimental liquid, d_0=density of water and ds=density of experimental liquid.

The experimentally determine values are listed in Table -1.

Calculated adiabatic compressibility, relaxation time, free volume, acoustic impedance, relative association, intermolecular free length, Rao's constant and Wada's constant for aqueous solution of ampicillin sodium at different concentration are given in Table-2 and 3.

Table 1, implies that the experimentally calculated values of ultrasonic velocity, density and viscosity of aqueous solution of ampicillin sodium increases with increase of concentration indicate strong attraction between the solute and solvent molecules.

Table 2 and 3, implies that the acoustic impedance, Rao's constant and Wada's constant increases whereas adiabatic compressibility, intermolecular free length, relative association relaxation time and free volume decreases with increase in concentration indicate non-ideal behavior of acoustical, thermodynamic parameters shows strong intermolecular interactions between solute and solvent molecule of aqueous solution of ampicillin sodium. This implies the formation of hydrogen bond between solute and solvent molecule of aqueous solution of ampicillin sodium. This observation similar to that of Anbanathan[15]and Ernst et. Al[16], in their studies of liquid mixtures reported the non-ideal behavior due to the

http://doi.org/10.29369/ijrbat.2023.02.1.0038

e-ISSN 2347 – 517X
Original Article

molecular association of water molecules. C. Roumana and et. At[17] in their studies of aqueous solution of cefadroxil reported non-ideal behavior attributed to strong intermolecular interactions.

The present investigation of aqueous solution of ampicillin sodium is in agreement with the reported observations indicate strong solute-solvent interaction in aqueous solution of ampicillin sodium.

CONCLUSION:

Reported acoustical parameters implies non-ideal behavior of ultrasonic velocity and acoustic, thermodynamic parameters indicate strong intermolecular interaction in aqueous solution of ampicillin sodium, which are responsible to drug absorption and transmission.

REFERENCES:

Kamila, S., Jena S. and Swain B. B. (2005): J. Chem. Thermodyn. 37: pp. 820-824.

Ali, A. and Nain Bull A. K. (2002): Chem. Soc. Jpn. 75: pp. 681-686.

Ramadan, A. T., Eid M. F., Seleim H. S. and Mahommad H. M. (1995) Thermochim. Acta 258: pp.219-223.

Paliwal, S. K. and Tabhane, V. A. (2004): J. Pure Appl. Ultrason., 26: pp. 105-110.

Swamy, K. M., Ranganathan S., Murayama K. L. and Bapuji, (2009): Proceedings of Eighteenth National Symposium on Ultrasonics, NSU-XVIII, Vellore: pp. 110-112.

Harish Kumar and Deepika, (2012): International Journal of Chemical Science and Technology, 2(1): pp. 1-5.

Roumana, C., Velraj, G., Akilandeswari P. E. and Mohammed Kamil M. G. (2009) Proceedings of Eighteenth National Symposium on Ultrasonics, NSU-XVIII, Vellore: pp. 144-148.

Kumar, R., Akilandeswari P.E., Mohamed Kamil M.G., Kannappan V. and Jayakumar S., (2010): Dilute solution viscometric, ultrasonic and refractometric studies of molecular interactions of human mixtard insulin with an antibiotic, J. Mol. Liquids 154: pp. 69-75.

Williams, R. G. and Pitt W. G. (1997) In vitro response of Escherichia coli to antibiotics and ultrasound at various insonation intensities, J. Biomater. Appl., 12: pp.20-30.

Baluja, S. H., Solanki A. and Kachhadia N.,(2007) An ultrasonic study of some drugs in solutions, Russian Journal of Physical Chemistry A volume 81: pp.742–746.

Pandey, J. D., Mishra K., Shukla A. and Rai R. D. (1987) Ultrasonic and thermodynamic studies of tetracyclines in solutions Canadian Journal of Chemistry, , 65(2): pp.303-306.

Kumar, R. Mohammed Kamil, M. G. Shri prsad, S. Gayatri, G. S. Shabeer, T. K., (2013) Indian J. of pure and applied physics, 51: pp.701-707.

Williams, R. G. and Pitt W. G. (1997): In vitro response of Escherichia coli to antibiotics and ultrasound at various insonation intensities, J. Biomater. Appl., 12, 20-30.

Pitt W. G., McBride M. O., Lunceford J. K., Roper R. J. and Sagers R. D., (1994): Ultrasonic enhancement of antibiotic action on Gram-negative bacteria. Antimicrob. Agents Chemother, 38, 2577-2582.

Anbanathan, D., (1974) J. Acoust. Soc. India, 4, 123-226.

Ernst, S. and Jezowska Trzebiatowska B., Phys. Chem., LPZ, 2, 256-259.

Roumana C., Velraj G., Roumaisa and Mohammed Kamil M. G., (2008) Acoustical investigation of molecular interaction in aqueous antibiotic solution, J. pure Appl. Ultrason, 30, 97-10.

http://doi.org/10.29369/ijrbat.2023.02.1.0038

e-ISSN 2347 – 517X
Original Article

Table 1: Ultrasonic Velocities, densities and viscosities of aqueous solution of ampicillin sodium at different concentrations

Concentration (M)	Ultrasonic Velocity (m/s)	Density (kg/ m^3)	Viscosityx10^{-3} (kg $m^{-1}sec^{-2}$)
0.001M	1456.63	1024.94	0.8514
0.01M	1528.85	1028.97	0.8896
0.1M	1598.42	1033.77	0.9639

Table 2: Acoustical parameters of aqueous solution of ampicillin sodium at different concentrations.

Concentration (M)	Adiabatic Compressibilityβx 10^{-10}	Specific Acoustic Impedance Zx10^4(Kgm^{-2}sec^{-1})	Intermolecular free length (L_f)	Relative association (R_A)	Acoustic relaxation time Ʈx10^{-10}sec
0.001M	4.59	14.9295	0.0134	1.039	5.2203
0.01M	4.15	15.7314	0.0127	1.0264	4.9321
0.1M	3.78	16.5239	0.0122	1.016	4.8660

Table 3: Thermodynamic parameters of aqueous solution of ampicillin sodium at different concentrations.

Concentration (M)	Free Volume V_fx10^{-8} (m3/mole)	Rao's Constant (R) (m^3/mole)(m/s)$^{1/3}$	Wada's Constant (W) (m^3/mole)(N/m^2)$^{1/7}$
0.001M	1.1920	0.1991	0.3790
0.01M	1.3770	0.2023	0.3844
0.1M	1.7567	0.2123	0.4027

http://doi.org/10.29369/ijrbat.2023.02.1.0038