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Research Article

ULTRASONIC STUDIES OF MOLECULAR INTERACTIONS IN THE SOLUTION OF LEAF EXTRACT OF *OCIMUM TENUIFLORUM* AT 2 MHZ

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ABSTRACT

Ultrasonic velocity (U), have measured at experimentally frequency 2 MHz in the binary mixtures leaf extract of *Ocimum Tenuiflorum* in distilled water with (0.1% to 0.0125 %) concentrations range at Temperature 30°C, 35°C & 40°C. Density ultrasonic velocity and viscosity used to estimate the acoustical parameters namely adiabatic compressibility (βa), relaxation time (τ), acoustic impedance (z), free length (Lf), free volume (Vf) and internal pressure (Pi), Wada's constant would prove to be more useful to predict and confirm the molecular interactions. A variation in these parameters will provide strong information regarding the molecular interactions taking place in the solution.

Keywords: Intermolecular free length, Acoustical parameters, Ultrasonic velocity.

1. INTRODUCTION

Our country is very well known for Ayurveda, in the Ayurveda medicines are largely made up from plants, herbs. One of such herbs is Tulsi which is also known as Holy Basil. Tulsi is known for its antifungal nature. In recent years ultrasonic technique has become a powerful tool in providing information regarding the molecular behavior of the liquids, polymer solutions and mixtures etc. [1-5]. Ultrasonic waves are used for both diagnosis and therapy. It includes the detection of wide variety of anomalies, such as tumor, bloodless surgery, proper extraction of broken teeth, cardiology, gynecology and kidney stone fragmentation [6-10]. The successful application of acoustic methods to physicochemical investigations of solution becomes possible after the development of adequate theoretical approaches and methods for precise ultrasound velocity measurements in small volumes of liquids [11, 12].

2. MATERIAL AND METHODS

The Tulsi leaf extract used in this study was of analytical range. Thermostatic water bath to maintain constant temperature. Mittal company Interferometer with an accuracy of 0.1%. at 2 MHz. The viscositiy (η) measured by using Ostwald's viscometer with an accuracy of ±0.001 PaSec. The density (ρ) of this binary solution was measured accurately. Using 25 mL specific gravity bottle in an electronic balance precisely and accurately. The basic parameter U, η, ρ were measured at solutions of leaf extracts of *ocimum tenuiflorum* at temperature 30°C, 35°C & 40°C.

By using ultrasonic velocity following ultrasonic parameters are calculated [13-20].

1. Ultrasonic velocity (υ): $\upsilon = f \times \lambda$ ms^{-1}
2. Adiabatic compressibility (κ): $\kappa = (1/\upsilon^2 \rho)$ $kg^{-1}\ ms^2$
3. Free volume (V_f):, $Vf = (M\,\upsilon/k\eta)^{3/2}$ m^3
4. Acoustic impedance (Z): $Z = \upsilon \times \rho$ $kg\ m^{-2}\ s^{-1}$
5. Free length (Lf):

   $L_f = (K\sqrt{\kappa})$

   κ = Adiabatic compressibility,.K=Temperature dependent constant(93.875+0.345T)x10^{-8}
6. Ultrasonic Attenuation (α/f^2): $\alpha/f^2 = 8\pi^2\eta/3\rho\upsilon^3$
7. Relaxation time (τ): $\tau = 4\eta/3\rho\upsilon^2$
8. Wada constant (W): $W = M.\ \kappa^{-1/7}/\rho$
9. Internal pressure (Πi):

$$\Pi i = b\ RT \left[\frac{k\,\eta}{\upsilon}\right]^{1/2} \frac{\rho_3^2}{M_6^7}$$

10. Cohesive energy (CE) : $CE = \Pi i Vm$

3. RESULT AND DISCUSSION

The measured values of ultrasonic velocity, density and related Thermo Acoustical parameters of Tulsi Leaf extract solution at temperatures 30ºC, 35ºC and 40ºC.

Table 1: Thermo Acoustical parameters of Tulsi Leaf extract solution

Solution	Density	Viscosity	Ultrasonic Velocity	Adiabatic Compressibility	Intermolecular Free length	Free Volume
Tulsi leaf extract solution at 30°C						
0.0125 %	996	$1.5035x10^{-3}$	1528	$4.28\ x10^{-4}$	$4.1113x10^{-8}$	$56.7317\ x10^{-7}$
0.025 %	997.6	$1.5524\ x10^{-3}$	1525	$4.27\ x10^{-4}$	$4.1065\ x10^{-8}$	$54.2324\ x10^{-7}$
0.05 %	999.6	$1.5742\ x10^{-3}$	1528	$4.27\ x10^{-4}$	$4.1025\ x10^{-8}$	$53.2665\ x10^{-7}$
0.1 %	1003.2	$1.645\ x10^{-3}$	1536	$4.24\ x10^{-4}$	$4.0885\ x10^{-8}$	$50.2432\ x10^{-7}$
Tulsi leaf extract solution at 35°C						
0.0125 %	994.8	$1.3449\ x10^{3}$	1508	$4.37\ x10^{-4}$	$4.1859\ x10^{-7}$	$66.0757\ x10^{-7}$
0.025 %	996.8	$1.4054\ x10^{3}$	1519	$4.32\ x10^{-4}$	$4.1597\ x10^{-7}$	$62.5333\ x10^{-7}$
0.05 %	998.4	$1.4269\ x10^{3}$	1526	$4.29\ x10^{-4}$	$4.1440\ x10^{-7}$	$61.5483\ x10^{-7}$
0.1 %	1002	$1.5191\ x10^{3}$	1528	$4.29\ x10^{-4}$	$4.1460\ x10^{-7}$	$56.141\ x10^{-7}$
Tulsi leaf extract solution of at 40°C						
0.0125%	994	$1.2634\ x10^{-3}$	1507	$4.38\ x10^{-4}$	$4.2230\ x10^{-8}$	$72.4992\ x10^{-7}$
0.025%	995.6	$1.2834\ x10^{-3}$	1510	$4.37\ x10^{-4}$	$4.2180\ x10^{-8}$	$71.0227\ x10^{-7}$
0.05%	996.8	$1.2939\ x10^{-3}$	1511	$4.37\ x10^{-4}$	$4.2178\ x10^{-8}$	$70.2297\ x10^{-7}$
0.1%	1000	$1.3606\ x10^{-3}$	1517	$4.35\ x10^{-4}$	$4.2078\ x10^{-8}$	$65.51\ x10^{-7}75$

Table 2: Acoustical parameters of Tulsi Leaf extract solution

Solution	Internal pressure	Acoustic Impedence	Relaxation time	Ultrasonic attenuation	Wada's constant	Cohesive energy
Acoustical parameters of tulsi leaf extract solution at 30°C						
0.0125 %	$23.0925\ x10^{-4}$	$1.5169\ x10^{-6}$	$4.6688\ x10^{-3}$	$1.1256\ x10^{-11}$	4.0859	$31.1702x10^{-4}$
0.025 %	$23.4670\ x10^{-4}$	$1.5223\ x10^{-6}$	$4.8319\ x10^{-3}$	$1.1535x10^{-11}$	4.0807	$31.6249\ x10^{-4}$
0.05 %	$23.6395\ x10^{-4}$	$1.5283\ x10^{-6}$	$4.9092\ x10^{-3}$	$1.1605\ x10^{-11}$	4.0736	$31.7937\ x10^{-4}$
0.1 %	$24.1623\ x10^{-4}$	$1.5419\ x10^{-6}$	$5.1661\ x10^{-3}$	$1.1898\ x10^{-11}$	4.0630	$32.3802\ x10^{-4}$
Acoustical parameters of tulsi leaf extract solution at 35°C						
0.0125 %	$22.3279x10^{-4}$	$1.5001\ x10^{-6}$	$4.0991\ x10^{-3}$	$1.0384x10^{-11}$	4.0799	$30.1745\ x10^{-4}$
0.025 %	$22.7722\ x10^{-4}$	$1.5141\ x10^{-6}$	$4.3375\ x10^{-3}$	$1.0595\ x10^{-11}$	4.0791	$30.7133\ x10^{-4}$
0.05 %	$22.9176\ x10^{-4}$	$1.5235\ x10^{-6}$	$4.4374\ x10^{-3}$	$1.0593\ x10^{-11}$	4.0769	$30.8598\ x10^{-4}$
0.1 %	$22.6877\ x10^{-4}$	$1.5310\ x10^{-6}$	$4.7195\ x10^{-3}$	$1.1193\ x10^{-11}$	4.0617	$30.8598\ x10^{-4}$
Acoustical parameters of tulsi leaf extract solution at 40°C						
0.0125 %	$21.9876\ x10^{-4}$	$1.4979\ x10^{-6}$	$3.8487\ x10^{-3}$	$9.7821\ x10^{-11}$	4.0829	$29.7386\ x10^{-4}$
0.025 %	$22.1627\ x10^{-4}$	$1.5033\ x10^{-6}$	$3.918\ x10^{-3}\ 9$	$9.8619\ x10^{-11}$	4.0777	$29.9272\ x10^{-4}$
0.05 %	$22.2637\ x10^{-4}$	$1.5061\ x10^{-6}$	$3.951\ x10^{-3}\ 4$	$9.911\ x10^{-11}$	4.0729	$30.0274\ x10^{-4}$
0.1 %	$22.8338\ x10^{-4}$	$1.5170\ x10^{-6}$	$4.1748\ x10^{-3}$	$1.026\ x10^{-11}$	4.0626	$30.6978\ x10^{-4}$

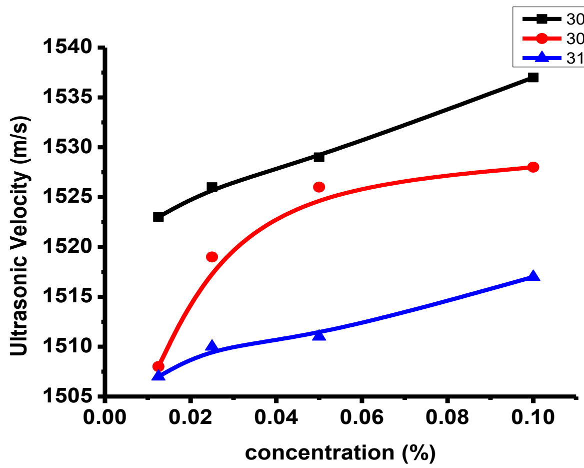

Fig. 1: Variation of Ultrasonic velocity with concentration and temperature

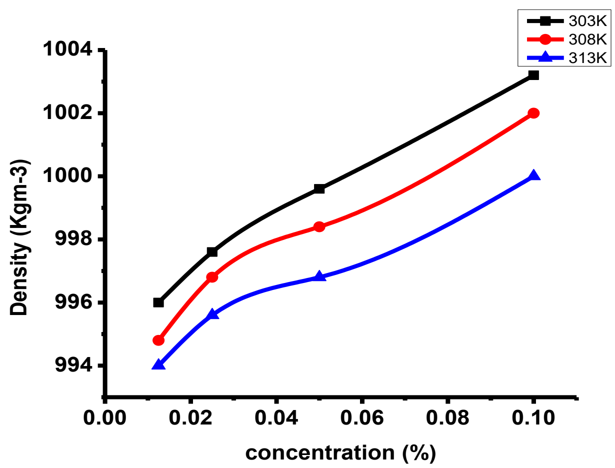

Fig. 2: Variation of Density with concentration and temperature

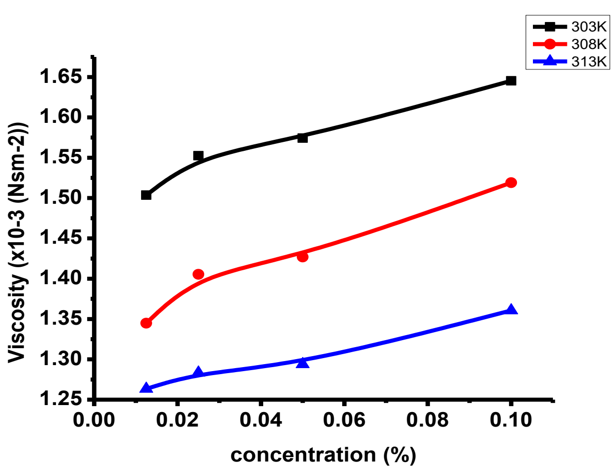

Fig. 3: Variation of Viscosity with concentration and temperature

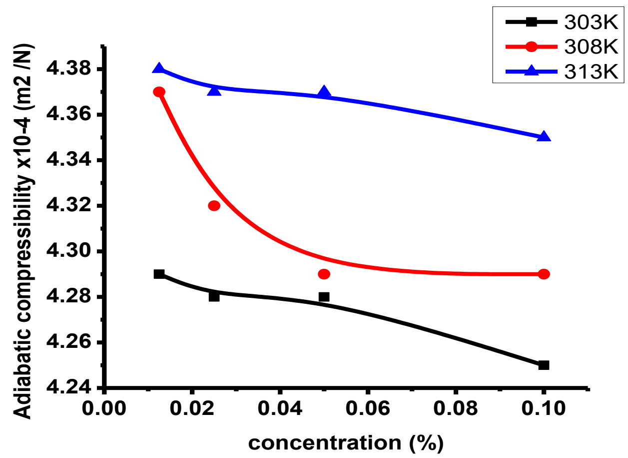

Fig. 4: Variation of Adiabatic compressibility with concentration and temperature

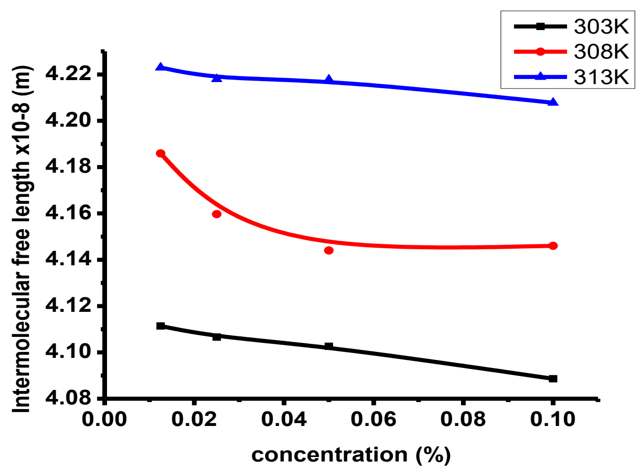

Fig. 5: Variation of Intermolecular free length with concentration and temperature

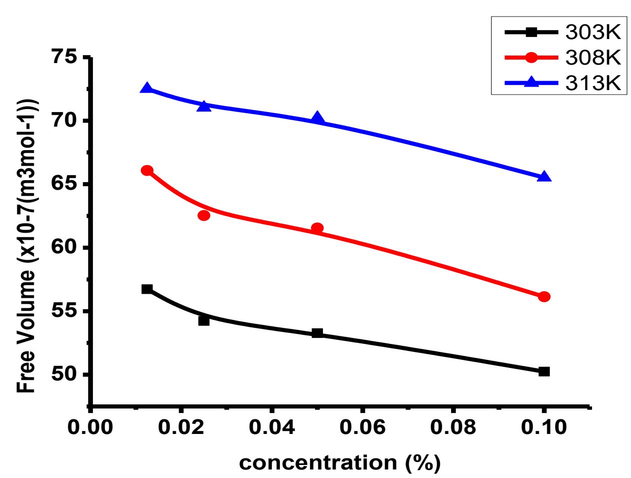

Fig. 6: Variation of Free Volume with concentration and temperature

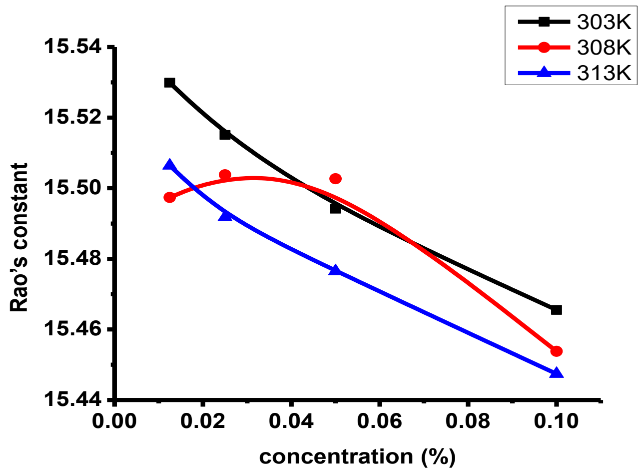

Fig. 7: Variation of Rao's constant with concentration and temperature

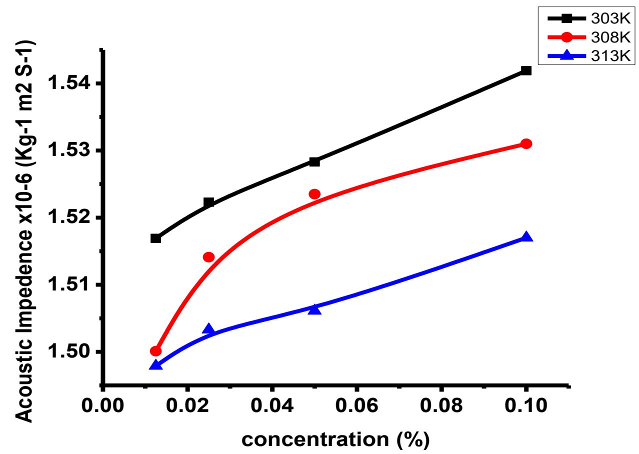

Fig. 10: Variation of Acoustic Impedance with concentration and temperature

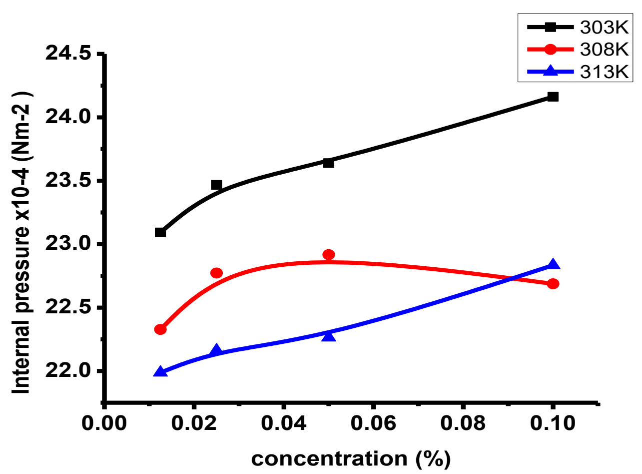

Fig. 8: Variation of Internal Pressure with concentration and temperature

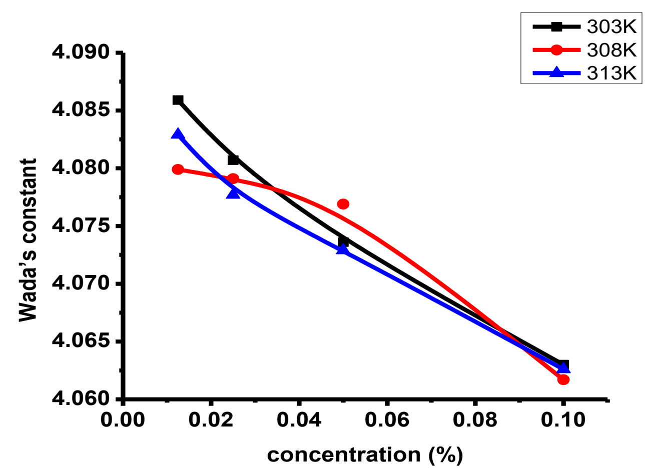

Fig. 11: Variation of Wada's constant with concentration and temperature

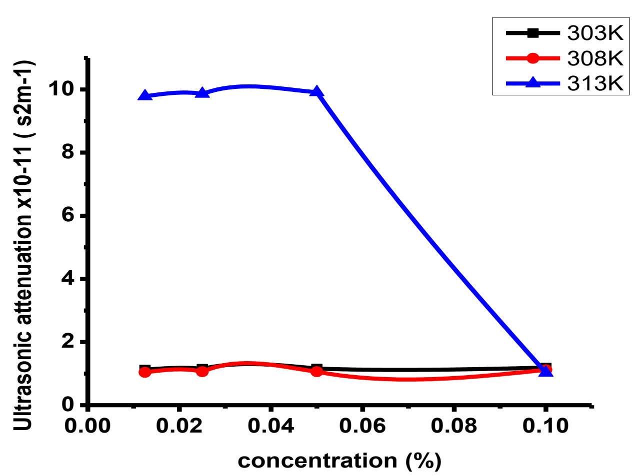

Fig. 9: Variation of Ultrasonic attenuation with concentration and temperature

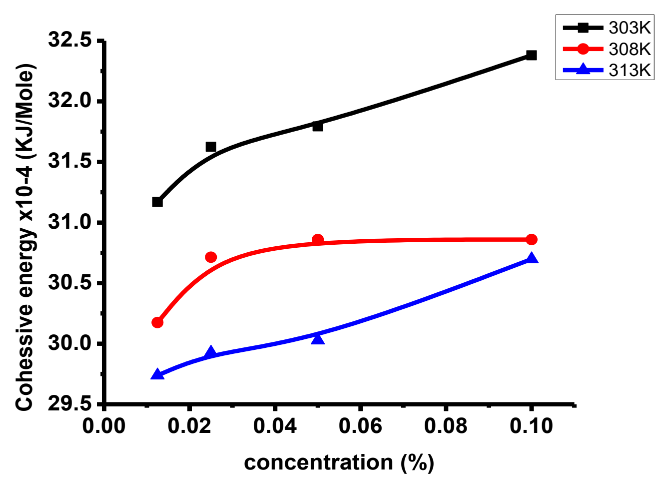

Fig. 12: Variation of Cohesive energy with concentration and temperature

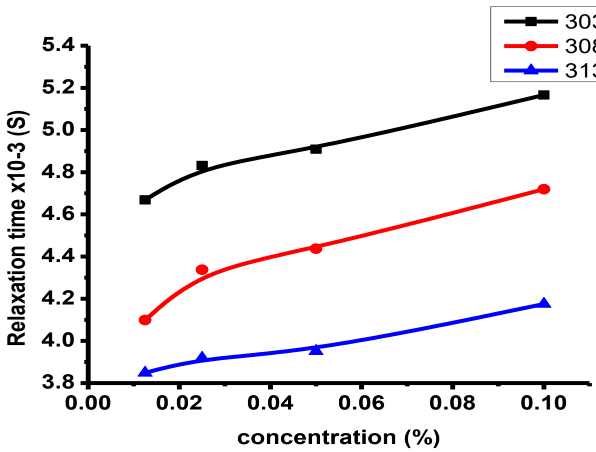

Fig. 13: Variation of Relaxation time with concentration and temperature

Ultrasonic velocity and Acoustic impedance represent nonlinear increasing Changes with increase in concentration of Tulsi leaf extract Solution. The complex formation and intermolecular weak association which may be due to hydrogen bonding. Adiabatic compressibility decreases with increase in concentration of Tulsi Leaf extract solution. The opposite trend of ultrasonic velocity and adiabatic compressibility in shows that the association among interacting Tulsi Leaf extracts solution. Free length varies nonlinearly with increase in concentration of Tulsi leaf extract Solution Shows the interaction between solute and solvent. Relaxation time decreases with increase in concentration Tulsi leaf extract Solution. Free volume increases and internal pressure decreases with increases in concentration of solution represent hydrogen bonding.

4. CONCLUSION

The variation in the values of ultrasonic velocity and other derived parameters are found to depend on composition of mixtures. These show the molecular interactions. The linear increase in the values of relative association with temperature for the Tulsi leaf extract in liquid mixture suggest that there are strong solute-solvent interactions at higher temperature. It is concluded the association in this liquid mixture is due to Hydrogen bonding in the binary liquid mixtures.

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6. REFERENCES

1. Gamow G and Cleveland J.M ,*Physics foundation and Frontier* Prentice Hall of India, Delhi, 1978**; 3rd Ed:** 155.
2. Duncan T, *Adanved Physics*, 2nd Ed., J. Murry. London,. 1981; 215.
3. Ameta SC, Punjabi PB, Swarnkar H, Chhabra N and Jain M, *J. Indian Chem. Soc*, 2001; **78:** 627**.**
4. Frizzell LA, *Encyl. Appl. Phys. Edr. G.L. Trigg, VCH Publ., New York*, 1998; **22:**475.
5. Wells PNT, *Biomedical Ultrasonics*, *Acad. London* 1977**.**
6. Shrivastava SK, Kailash Bull, *Mater. Sci*, 2004; **27(4):** 383.
7. 7. Scars FW, Zemansky MW, Young FD, *College Physics*, 4th Ed., Addison- Wesley Publishing Co., London, 1974; 366.
8. Aswar AS, *Ind. J. Chem*., 1997; **36A:** 495-498.
9. Fakruddin S, Srinivasu C, Sarma NT.Kolla N, *Journal of Chemical, Biological* 2008; 87.
10. Gomes R, AndradeMJ, Santos M, Lima S, Gouveia RA, Ferreira MM, Silva JA. *Cardiovascular Ultrasound*, 2009; **7:**36 .
11. Palmowski L, Simons L, Brooks R, *Water Sci. Tech*, 2006; **53(8):** 281-288 .
12. Ali A,. Nain Ak, Sharma VK, Ahmad S, *ternary mixtures through ultrasonic Phy. Chem. Liq*, 2004; **42:** 375-383.
13. Kannappan V, Mahendran S, Sathyamoorthy P, Roopsingh D, *J. Poly. Mat*, 2001; **18:** 409-416.
14. Gomes R, Andrade MJ, Santos M, Lima S, Gouveia RA, Ferreira MM, *J. Aniceto, Cardio. Ultra*, 2009; **7**:36.
15. Balankina ES, Lyashchenko AK, *J. Mole. Liqd,* 2002; **101:**273-283.
16. Mecozzi M,Amici M, Pietrantonio E, Romanelli G, *Ultra. Sonochem*, 2002; **9:**11-18.
17. Kannappan AN, Palani R, *Ind . J.Pure and Appl. Phys*, 2007; **46A:**54-59.
18. Vasanth Aran P, Kalaimagal P, Kannappan AN , *Asian J.applied Scien*, 2009; **2(1):**96-100.
19. Rao GV, Viswanatha Sarma A, Siva Rama Krishna J, *Ind . J. Pure Appl. Phys*, 2019; **43:**345-354.
20. Mecozzi M, Science and Biotechnology volumes, 2015; **24:**1951-1958.
21. Andrade MJ, Santos M, *The International Journal of Advanced Manufacturing Technology***,** 2021**; 113**:3079-3120.