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Ultrasonic Investigation of Molecular Interaction in Herbal Extract Pomegranate Solutions At Different Frequencies

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Abstract:

Ultrasound assisted extraction process is the modern method used in allied industries Herbal extract of pomegranate is widely used in the skin care treatment. This includes herbal extracts, oil, protein and bioactives from plants and animal materials. In the present study, our aim is to find the activity of present drug by ultrasonic velocity measurement in aqueous medium.

Intermolecular interaction study plays an important role in development of molecular sciences. The ultrasonic velocity of liquid is fundamentally related to the binding forces between the atoms or molecules. Ultrasonic parameters provide valuable information about various inter and intramolecular interactions in solutions. The ultrasonic velocity (v), density (ρ) and viscosity (η) for the aqueous solution of herbal extract of pomegranate[1-2] at 1% concentration of different frequency like 2MHz,4MHz and 6MHz have been measured at 298K. The data is used to evaluate the ultrasonic parameter such as adiabatic compressibility (β_S), intermolecular free length (L_f), acoustic impedance (Z), relative strength (r), relaxation time (τ) etc. These calculated values are interpreted to elucidate the molecular interactions in the liquid mixture.

Keywords: 1% Pomegranate extract solution, Ultrasonic velocity

Introduction:-

This method ensures that the extracts have a much higher shelf life while it is highly concentrated to a required guaranteed potency level. The significance of herbal extract in relation to synthetic drugs is that herbal drugs are absorbed by the body very quickly especially in older adults.

In India, herbs are widely used for the purpose of worship and sensual enjoyment. also the herbals are used as whole or part for various ailment of the skin, hair and for overall appearance[3].

Ultrasonic technique is the most important and universally accepted technique to study the physical and chemical properties of solution[4-7]. The measurement of ultrasonic velocity in liquid and liquid mixtures provide valuable information about the physico chemical parameters and the nature of molecular interactions in them[8-9].

Ultrasonic velocity measurement have been widely used in the field of molecular interactions and structural aspects. Number of workershave carried out ultrasonic studies of liquid in aqueous as well as non aqueous medium[10-13]. The molecular interaction between pomegranates with water as a solvent at 298K have been investigated in the present paper, again this gives idea about solubility of pomegranate in solvents like water. By the measurement of ultrasonic velocity, density and viscosity of the solution at 298K at 2MHz, 4MHz and 6MHz frequencies, the acoustic properties like Adiabatic compressibility (β), Specific acoustic impedance (Z), Relative strength (r), Intermolecular free length (L_f) and Relaxation time (τ) are determined.

Experimental:-

All the chemicals used were of analytical Range. Double distilled water was used for the preparation of solutions. A special thermostatic water bath arrangement was made to maintain constant temperature. 1% solution of pomegranate extract was prepared by taking accurate weights on electronic digital balance. (Model CB/CA/CT-series).

Ultrasonic velocity and density measurements are necessary to determine the acoustic parameters of solutions. Ultrasonic velocity through 1% solution of pomegranate extract in water was measured with the Mittal type (Model,M-83,Mittal Enterprizes) multifrequency ultrasonic interferometer at different frequencies with an accuracy of ±2 m/s. All the readings were taken at 298K viscosity of solution was measured by Ostwalds viscometer and density of solution was measured by Digital Densitometer (DMA-35,Antonpaar)

Computations:-

By using Ultrasonic velocity, following acoustic parameters are calculated,

Adiabatic compressibility :-

$\beta_S = 1/v^2d$ Where v- Ultrasonic velocity

d =Density.

Specific acoustic impedance :-

$Z = v.d_s$ d_s = Density of solution

Intermolecular free length :-

$L_f = K.\sqrt{\beta_S}$ K = Jacobsons constant(631)

β_S = Adiabatic compressibility of solution

Relaxation time is used to study the intermolecular interaction. It has been calculated by using adiabatic compressibility (β_S) by Jacobsons formula,

$\tau = 4/3\ \beta_S \eta$ Where η =Viscosity

Relative strength:- $r = 1-(v\backslash v_\infty)^2$

v -velocity

v_∞ - 1600ms^{-1}

Results and Discussion:-

The experimentally determined values are listed in following tables.

The ultrasonic velocity of 1% pomegranate extract solution in water was measured at 298K at 2MHz,4MHz and 6MHz frequency. From table no.1, It is observed that at different frequenies if conentration is constant, ultrasonic velocity is increases. From table no.2, Specific acoustic impedance (Z) increases with increase in frequency. Adiabatic compressibility (β) increases with increase in frequency. It is observed from table no.2 intermolecular free length (Lf) increases with increase in frequency, relative strength (r) increases with the decrease in frequency ,rexation time(τ) increase with increase in frequency. From the pomegranate extract and the solvent, bonds between solute-solvent strengthen the intermolecular forces resulting in the increase of adiabatic compressibility with the increase of frequency.

Increase in the acoustic impedance with the increase of frequency is an indication of strong interaction between pomegranate extract and solvent. From the above it is observed that molecular association between pomegranate extract-solvent molecules, may arise from intermolecular hydrogen bonding which strongly supports the molecular association occurring in these systems.

The variation in the acoustical parameters with temperature and concentration for different frequency, Pomegranate extract solution in water suggests that there are strong solute-solvent interactions at higher frequency

Table. 1- Density,Velocity,Viscosity of Pomegranate extract solution at 298K.

Sr.No.	Concentration (%)	Frequency MHz	Density d_s	Velocity V_s m/s	Viscosity × 10^{-3} (Kgm^{-1} s^{-2})
1	1	2	1001.2	2441.77	1.3855
2	1	4	1001.2	2801.0	1.3855
3	1	6	1001.2	4648.65	1.3855

Table 2 : Acoustic Parameters of Pomegranate extract solution at 298K.

Sr. No.	Concertration (%)	Frequency MHz	Adiabatic compressibility β×10^{-5} (pa^{-1})	Specific acoustic impedance Z×10^5 (Kgm^{-2} Sec^{-1})	Intermolecular free length(m) Lf × 10^{-8}	Acoustic relaxation time τ×10^{-7}	Relative strength r
1	1	2	16.7923	24.4470	2.5482	3.1021	-1.329
2	1	4	12.7511	28.0212	2.2358	2.2321	-2.0646
3	1	6	4.6279	46.4911	1.3612	0.7499	-7.4413

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