Comparative Studies of Acoustic Parameter of Jatropha Curcas leaves extract in non-polar solvent at different Concentration

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Abstract: - Medical plants have received a lot of attention lately for preserving human health due to their less adverse effects. Phytochemical metabolites are what give traditional plants their medicinal qualities. This paper examines the ultrasonic parameters of Jatropha leaf extract in n-hexane, a non-polar solvent. The structural alterations linked to molecule interaction in liquid mixtures are shown by variations in ultrasonic velocity and associated parameters like as viscosity, acoustic impedance, adiabatic compressibility, intermolecular free length, and relaxation time.

Keywords: - Interferometer; acoustic parameter; molecular interaction; Jatropha Curcas; non-polar solvent; n-hexane etc.

Introduction: - A WHO survey indicates that 80% of people in underdeveloped nations, including India, rely on traditional plant-based remedies [1]. Herbal medicines have garnered significant attention due to their low toxicity and minimal side effects [2]. Jatropha curcas, a multipurpose plant belonging to the Euphorbiaceae family, is considered a renewable source of seed oil for biodiesel production [3,4]. Studies on the leaf extract of this plant have demonstrated its antitumor and antimicrobial potential [5]. Additionally, research has provided insights into the extraction process, phytochemical analysis, and biological evaluation of J. curcas plant extracts. In this study, we aimed to investigate the nature of molecular interactions through ultrasonic analysis of J. curcas leaf extract in hexane as a solvent. The ultrasonic approach offers valuable information about the physicochemical properties [6] of liquid mixtures by analyzing molecular interactions [7]. These These interactions influence the structural arrangement of the components within the solution mixture [8]. Hexane was selected as the solvent for this study due to its extraction efficiency and commercial significance.

Methodology: -

The plant material was collected from the natural habitat of Dhar (M.P.). The sample was washed under running water, shade-dried, ground into a coarse powder, and stored in an airtight container for extraction [9]. For Soxhlet extraction, 20 grams of the coarsely ground leaf powder was used with 150 milliliters of hexane as the solvent, and the process was carried out for four hours [10]. The resulting extract solution was allowed to cool, filtered through Whatman filter paper, and concentrated to obtain a dry extract [11].

Experimental Set Up:

Ultrasonic interferometer was used to determine ultrasonic velocity with high accuracy and

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least count of ±0.01m/s [12]. Ultrasonic Velocity can be determining as-

Ultrasonic Velocity = Frequency × Wavelength

$U = f \times \lambda$

$U = f \times (d/2)$

Where d = distance between two successive maxima or minima measured by interferometer [13] The density of liquid mixture was measured using gravity bottle and electronic balance [14] Viscosity were measured by Ostwald viscometer and digital stop watch [15]. Using standard formula, acoustic parameter has been calculated.

1. Acoustic Impedence Z = Velocity × Density.
2. Adiabatic Compressibility β/ Isentropic Compressibility $\beta_S = 1/\{(\text{Velocity})^2 \times \text{Density}\}$.
3. Intermolecular Free Length $L_f = K\sqrt{(\text{Adiabatic Compressibility})}$ K= Jacobson's Constant= $(93.875+0.375T) \times 10^{-8}$

Where T = temperature in Kelvin.

1. Viscous Relaxation Time(τ) = [(4×Adiabatic Compressibility× Viscosity)/3] [16,17].

Result and Discussion: -

All experiments conduct at room tempture(296K) and 2MHz frequency. The parameter measured ultrasonic velocity(U), viscosity(η) and density(ρ) of pure liquid and mixture are shown in Table 1 and Table 2 represent the calculated acoustic parameters.

Table 1: Calculation of U, ρ, Ƞ for different sample of J. Curcas leaves extract in Hexane

Sample	**Ultrasonic Velocity U** (m/s)	**Density ρ** ($Kg/m^3 \times 10^{-3}$)	**Viscosity Ƞ** ($Pa/s \times 10^{-3}$)
Distil Water	1496	997	1.0000
Pure solvent	1102.6	726	0.7110
2.5% w/v Solution	1102.8	723	0.7348
5.0% w/v solution	1096.8	725	0.7259
7.5% w/v Solution	1088	728	0.7249
10% w/v Solution	1105.2	733	0.7228

From the experimental data of ultrasonic velocity (U), density (ρ) and viscosity (Ƞ) for Jatropha Curcas leaves sample in hexane solvent, other physical parameters have been determined for liquid mixture composition. The computed parameters and their values are reported in table 2. The comparative deviation of these variable with change in concentration are shown in fig. 1-4.

Table 2: - Calculation of Z, β, L_f, τ for different concentration of Jatropha Curcus leaves extract in Ethanol and Methanol

Sample	Acoustic Impedance $Z \times 10^5$	Adiabatic Compressibility $\beta \times 10^{-10}$	Inter Molecular Free Length $L_f \times 10^{-21}$	Relaxation Time $\tau \times 10^{-12}$
unit→ conc.↓	**$Kgm^{-2}s^{-1}$**	**$Kg^{-1}ms^2$**	**Meter**	**Sec**
Pure solvent	8.0049	11.3299	6.8961	1.0741
2.5% w/v Solution	7.9732	11.3728	6.9091	1.1142
5.0% w/v solution	7.9518	11.4659	6.9373	1.1097
7.5% w/v Solution	7.9206	11.6041	6.9790	1.1215
10 % w/v Solution	8.1011	11.1690	6.8469	1.0764

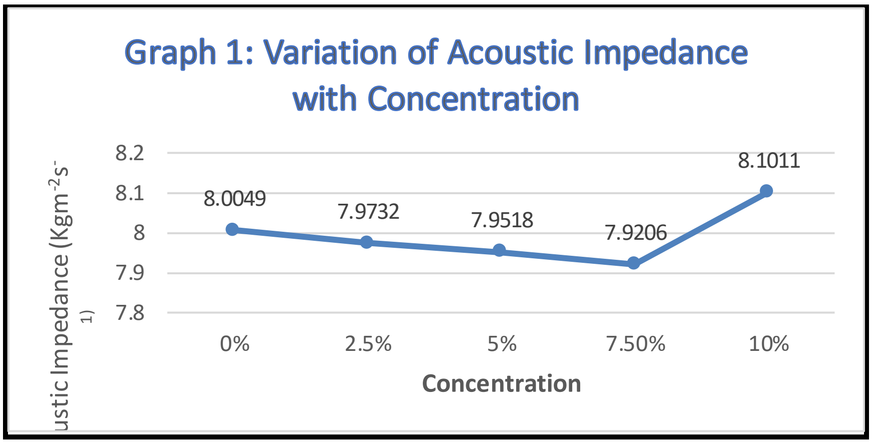

Fig.1: Variation of Acoustic Impedance with Concentration

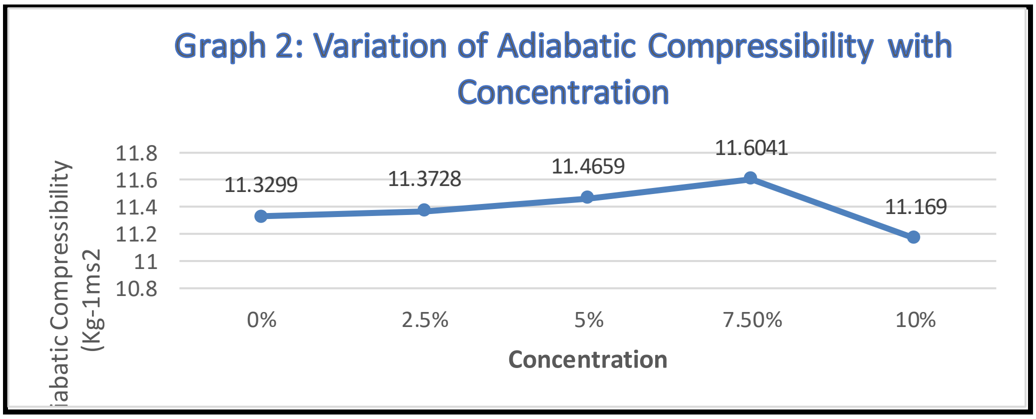

Fig.2: Variation of Adiabatic Compressibility with Concentration

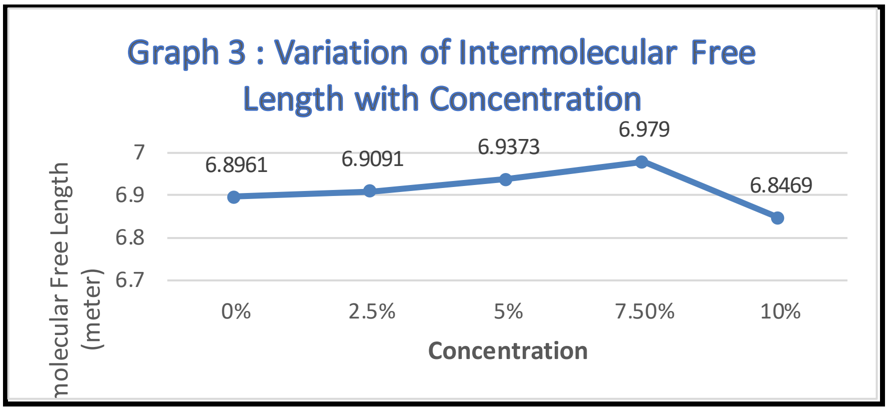

Fig.3: Variation of Intramolecular free Length with Concentration

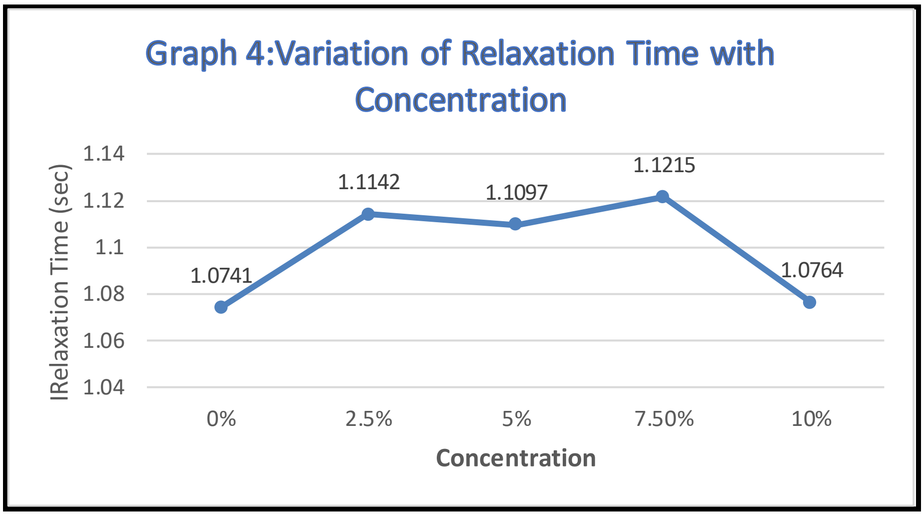

Fig.4: Variation of Relaxation Time with Concentration

Conclusion:-

Acoustic impedance of components is the opposite force applied by medium to displace the particles of same medium [18]. It is associated with elastic properties of solution[19]. The ascending plot supported by variety of literature [19,20]. Variation of Acoustic impedance attributed to the effective interaction between extract and solvent. It may be due to the presence of several functional group in mixture. Relaxation time value decreases but further rises at higher concentration. It was found that variation in τ is mainly due to change in viscosity of liquid mixture. The measured data from experiments have been used to calculate some thermo–acoustic parameters. The computed data provides a better insight about the molecular interaction and packing. The lowering of adiabatic compressibility indicates the existence of solvent – solvent association and increasing value of these parameter support for solute – solvent interaction. The observed trends in acoustic parameters may correlate with the extract's physicochemical properties, aiding in quality control or pharmaceutical formulation.

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