

## Thermo – Acoustic Comparison of Borassus Flabellifera BF and Adansonia Digitata and Liquid



### Physics

**KEYWORDS :** BorassusFlabellifera' BF, AdansoniadigitataAnD, density, ultrasonic velocity,compressibility.

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### ABSTRACT

*The change in the wavelength of ultrasonic waves in different medium is due to the elastic properties and the induced particles vibrations in the medium. The study of propagation of ultrasonic wave in liquid systems and solids is now rather well established. Ultrasonic waves are an effective means for examining and analysing certain physical properties of the materials. In the present study, we have measured density, ultrasonic velocity of 'BorassusFlabellifera' BF and AdansoniadigitataAnD binary liquid mixture with double distil water at different concentration at room temperature. Natural sample 'BorassusFlabellifera' BF fruit pulp and AdansoniadigitataAnD powder was collected from Dhar, District of MP, India for this study. From these experimental data, thermodynamic and acoustic parameters of 'BorassusFlabellifera' BF fruit pulp and AdansoniadigitataAnD powder binary liquid mixture with distil water of different concentration at room temperature were calculated and the results have been compared on the basis of molecular interaction occurring in the solution. For the measurement of ultrasonic velocity, we used Multifrequency Ultrasonic interferometer Model M-81 S because ultrasonic is popular non destructive technique. Density was measured by density bottle. Authors calculated compressibility and impedance of binary liquid by the measured values of density and ultrasonic velocity.*

### INTRODUCTION

The study of physicochemical behaviour and molecular interactions in liquid mixture is of considerable importance and a number of experimental techniques have been used to investigate the interactions between the components of binary liquid mixtures [1-5]. In recent years, the measurement of ultrasonic velocity has been extensively applied in understanding the nature of molecular systems, physicochemical behaviour and molecular interactions in liquid mixtures [6-8].

The accurate thermodynamic data on dilute electrolyte and non-electrolyte solution are frequently needed. The sound velocity is a thermodynamic function. Many other thermodynamic properties of electrolyte and non-electrolyte solutions are determined from sound velocities [9, 10]. These accurate thermodynamic properties of dilute electrolyte and non-electrolyte solutions are frequently needed for their use in medicine, engineering, agricultural industry and particularly in chemistry. Attempts are being made to understand different interactions through their properties like density, ultrasonic velocity, compressibility, and acoustic impedance which are convenient parameters in interpreting molecular interaction in solution phase [11, 12].

Density and ultrasonic velocity measurement are mainly done to investigate electrolytic and non-electrolytic behaviour of molecules in distil water of binary liquid mixtures [13]. Very insufficient data on the solvation behaviour of ions are available in mixed solvents [14]. Ultrasonic velocity and isentropic compressibility are quite sensitive to changes in ionic concentrations in distil water and binary liquid mixtures of BF fruit pulp and AnD fruit powder [15-21]. The isentropic compressibility and acoustic impedance are the functions of ultrasonic velocity [22-24]. As these parameters are a more accurate measure to study the solute-solvent interactions, an ultrasonic study on solutions of BF fruit pulp and AnD fruit powder in double distil water has been made at room temperature 308K.

The study of propagation of ultrasonic wave in liquid systems and solids is now rather well established. Ultrasonic waves are an effective means for examining and analyzing certain physical

properties of the materials. It is universally adopted to examine the changes in such physical properties while they occur. In the present study authors are analyzed aqueous [25] solutions of 'Adansonia Digitata' AnD and 'Borassus Flabellifera' BF fruit pulp, which is available in Western part of MP, India, at various concentrations, have been experimentally determined. Values of acoustical parameters such as Acoustic impedance (Z) and Isentropic compressibility ( $\beta_s$ ) were computed with the viewpoint importance and applicability in asserting the interactions.

### MATERIAL AND METHOD:

The AnD fruit was collected from the markets of Mandu District Dhar MP India and 'Borassus Flabellifera' BF fruit pulp was collected from the Kukshi District Dhar MP India. First both the fruit are dried up to nearly zero percent moisture content in shadow. Further powdered and prepared the binary liquid in different concentration with double distil water. Double distil water was prepared in our laboratory. For the measurement of ultrasonic velocity, we used Multifrequency Ultrasonic interferometer Model M-81 S because ultrasonic is popular non destructive technique. Density was measured by density bottle. All the measurements were taken at room temperature 308K.

### THEORY AND CALCULATION:

Isentropic compressibility and acoustic impedance and can be calculated from the ultrasonic velocity (U) and the density of the medium ( $\rho$ ) using the equations (26) as:

$$\beta_s = 1/U^2\rho \quad \text{----- (1)}$$

$$Z = U\rho \quad \text{----- (2)}$$

### RESULT AND DISCUSSION:

The sound velocity and the concentration of a liquid medium are related via its density isentropic compressibility and acoustic impedance. In the simplest case, this dependence is linear. In the majority of cases, however, both sound velocity and density curves are non-linear. In order to measure the concentration, the characteristic concentration curves of the measured medium must first be determined, if not already known.

In order to calibrate the measuring rig, a documented reference medium was measured first in double distil water. Afterward, the sound velocity of the medium to be measured in the production process was determined as a function of concentration at room temperature.

**Table 1.**  
**Density, ultrasonic velocity, isentropic compressibility and acoustic impedance at room temperature.**

S.No.	Sample	Concentration	Density $\rho \times 10^3$	Ultrasonic Velocity U	Isentropic Compressibility $\beta_s \times 10^{-10}$	Acoustic Impedance Z X $10^6$
1	AnD Powder With Distil Water	Double Distil Water	0.9937	1517	4.3729	1.5074
		0.001 kg ample: 20ml Distil water	0.9998	1529.67	4.2746	1.5294
		0.001 kg Sample: 40ml Distil water	0.9993	1527.84	4.2869	1.5268
		0.001 kg Sample: 60ml Distil water	0.9987	1525.13	4.3048	1.5231
		0.001 kg Sample: 80ml Distil water	0.9962	1524.53	4.3190	1.5187
		0.001 kg Sample: 100ml Distil water	0.9951	1523.64	4.3288	1.5162
		2	BF Fruit Pulp With Distil Water	Double Distil Water	0.9937	1517
0.001 kg ample: 20ml Distil water	1.008			1526.66	4.2565	1.5389
0.001 kg Sample: 40ml Distil water	1.0042			1525.33	4.2801	1.5317
0.001 kg Sample: 60ml Distil water	1.0025			1522.1	4.3056	1.5259
0.001 kg Sample: 80ml Distil water	1.0011			1521.54	4.3148	1.5232
0.001 kg Sample: 100ml Distil water	0.9983			1517.12	4.3521	1.5145

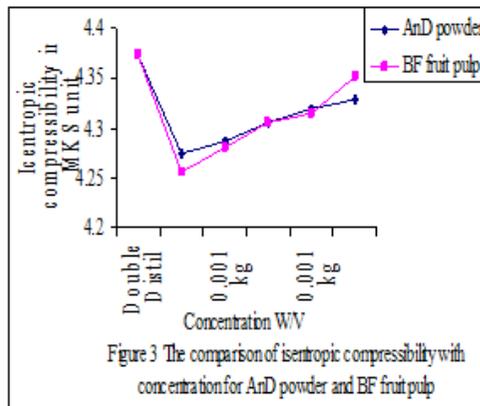


Figure 3 The comparison of isentropic compressibility with concentration for AnD powder and BF fruit pulp

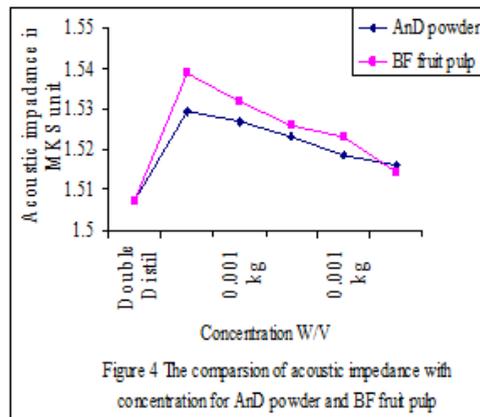


Figure 4 The comparison of acoustic impedance with concentration for AnD powder and BF fruit pulp

The measured values of density and velocity at temperatures 308 K for the pure distil water and for the system aqueous solution of BF and AnD1 are given in Table 1. The calculated values of isentropic compressibility ( $\beta$ ) and acoustic impedance at room temperatures for the double distil water and for the mixtures are presented in Table 1. The respective measured and calculated values at room temperatures have been shown in Figs 1-4. Figure 1, 2 & 4 shows that the values of density, ultrasonic velocity and acoustic impedance decreases with increasing concentration of double distil water in BF and AnD binary liquid mixtures. It is found that the ultrasonic velocity decreases with increasing concentration of double distil water. The structural changes of molecules in the mixture take place due to the existence of electrostatic field between the interacting molecules. Thus the structural arrangement of molecules results in the effect of isentropic compressibility ( $\beta_s$ ), which shows an inverse behaviour as compared to the ultrasonic velocity.

The increase in the compressibility with concentration in the case of lower members is due to the loose packing of the molecules inside the shield, which may be brought about by weakening of molecular interactions. The regular fall in compressibility causes a rise in sound velocity in the mixture. Further, this trend is an indication of clustering together of the molecules into same cage like agglomerates due to associative effect of the polar group predominating over the other types of interactions. The compressibility and acoustic impedance vice versa with increasing concentration of double distil water in binary liquid mixtures of BF and AnD.

**CONCLUSION:**

As the inert solvent, double distil water in BF and AnD, the free space between the component molecules increases, leading to a decrease in velocity of increase in compressibility at lower mole fractions of binary liquid mixtures of BF and AnD. However, as the mole fraction of double distil water decreases, the rupture of

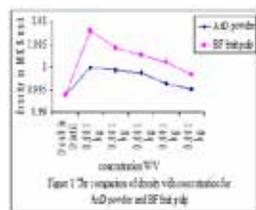


Figure 1 The comparison of density with concentration for AnD powder and BF fruit pulp

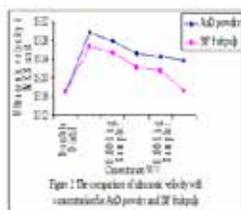


Figure 2 The comparison of ultrasonic velocity with concentration for AnD powder and BF fruit pulp

hydrogen bonds is restricted and hence the free space between the component molecules decreases.

The deviation of a parameter from the ideal behaviour is a measure of the interaction between the molecules, which may be due to either adhesive or cohesive forces. They can give an idea about the non-ideality of the system as a consequence of associative or other types of interactions. The isentropic compressibility and acoustic impedance are positive in these systems at room temperature indicating weak interactions between the components of mixtures.

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