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Gibb's energy and intermolecular free length of '*Borassus Flabellifier*' (BF) and *Adansonia digitata* (AnD) aqueous binary mixture

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Abstract. One of the potential driving forces behind a chemical reaction is favourable a new quantity known as the Gibbs free energy (G) of the system, which reflects the balance between these forces. Ultrasonic velocity and absorption measurements in liquids and liquid mixtures find extensive application to study the nature of intermolecular forces. Ultrasonic velocity measurements have been successfully employed to detect weak and strong molecular interactions present in binary and ternary liquid mixtures. After measuring the density and ultrasonic velocity of aqueous solution of '*Borassus Flabellifier*' BF and *Adansonia digitata* AnD, we calculated Gibb's energy and intermolecular free length. The velocity of ultrasonic waves was measured, using a multi-frequency ultrasonic interferometer with a high degree of accuracy operating Model M-84 by M/s Mittal Enterprises, New Delhi, at a fixed frequency of 2MHz. Natural sample '*Borassus Flabellifier*' BF fruit pulp and *Adansonia digitata* AnD powder was collected from Dhar, District of MP, India for this study.

1. Introduction

The measurements of ultrasonic speed in liquid mixture enables accurate determination of some useful acoustical and thermo dynamical parameters are highly sensitive to molecular interactions in their mixtures. Acoustic and thermodynamic parameters have been used to understand different kinds of association, the molecular packing, molecular motion and various types of intermolecular interactions and their strengths influenced by the size in pure components and in the mixtures [1-5]. These parameters play a vital role in assessing the compactness due to molecular arrangement and the extent of molecular interactions in the liquid mixtures through charge transfer, dipole-dipole and dipole induced dipole interactions [6]. Their dependence on concentration, temperature and frequency are of importance in many fields of applied research and also find applications in many important chemical, industrial and biological processes [7]. The aim of this work is to ascertain the nutritive values of BF and AnD fruit, so as to encourage its use and inclusion in human food. The AnD fruit consists of a hard, woody outer shell with a dry, powdery substance inside that covers the hard, black kidney-shaped seeds Phytic acid (myo-inositol hexa phosphate) is a thermolabile rachitogenic agent (Aletor, 1993). It is an important constituent of certain legumes, cereals and forage plants which is capable of chelating divalent cationic minerals like calcium, iron, magnesium and zinc (Liener, 1983). BF fruit



as the major species has many traditional uses. They have been used in treating gonorrhoea, dysentery, and respiratory disease. BF fruit sap is prized as a tonic, diuretic, stimulant, laxative, anti-phlegmatic and amebicide [8]. Sugar from the sap is a typical agent used to counteract poisoning and prescribed in treating liver disorders, and the pulp of the matured fruits is known to relieve dermatitis. In thermodynamics the Gibbs free energy is a thermodynamic potential that measures the "useful" or process-initiating work obtainable from an isothermal, isobaric thermodynamic system. Just as in mechanics, where potential energy is defined as capacity to do work, similarly different potentials have different meanings. Gibbs energy is the capacity of a system to do non-mechanical work. Attractive or repulsive interactions that occur between all atoms and molecules. Intermolecular forces become significant at molecular separations of about one nano meter or less, but are much weaker than the forces associated with chemical bonding. They are important, however, because they are responsible for many of the physical properties of solids, liquids, and gases. These forces are also largely responsible for the three-dimensional arrangements of biological molecules and polymers.

2. Material and Method

The fresh fruits of *Borassus flabellifer* BF and *Adansonia digitata* And were bought from market Kukshi and Mandu of district Dhar (M.P.). The fresh fruits were washed and air dried. Pods/bark of the fruit were removed, cut into pieces and blended. Aqueous extract of each was obtained, filtered and stored in a clean sample container in the fridge until needed for analysis. The velocity of ultrasonic waves was measured, using a multi-frequency ultrasonic interferometer with a high degree of accuracy operating Model M-84 by M/s Mittal Enterprises, New Delhi, at a fixed frequency of 2MHz [9] and density by density bottle. After measuring density and ultrasonic velocity and density [10], we calculated Gibb's free energy and inter molecular free length [11], of BF and AnD Aqueous Binary Mixture.

3. Result and Discussion

Intermolecular free length and Gibb's free energy increases with the concentration double distil water in both the binary mixture of BF and AnD fruit pulp. The increase in Gibb's free energy suggests shorter time for rearrangement of molecules.

This also indicates existence of molecular association between the components of the liquid mixture. Absorption coefficient, which is a characteristic of the medium, increases In order to understand more about the nature of the interaction between the components of the liquid mixtures, showed in Table 1

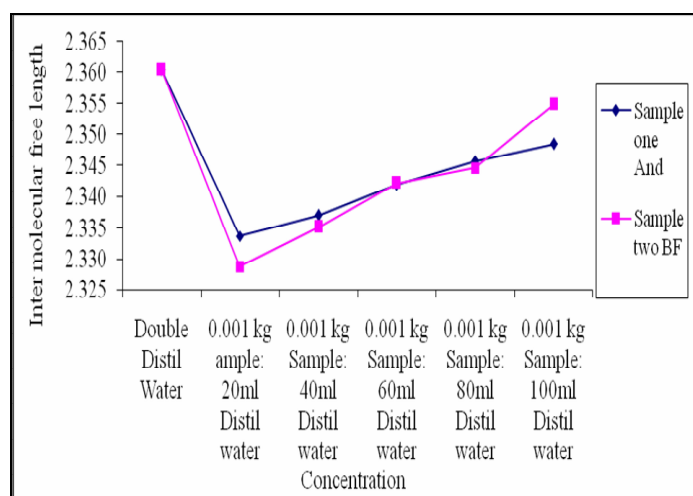


Figure 1. Intermolecular free length of BF and AnD aqueous binary mixture

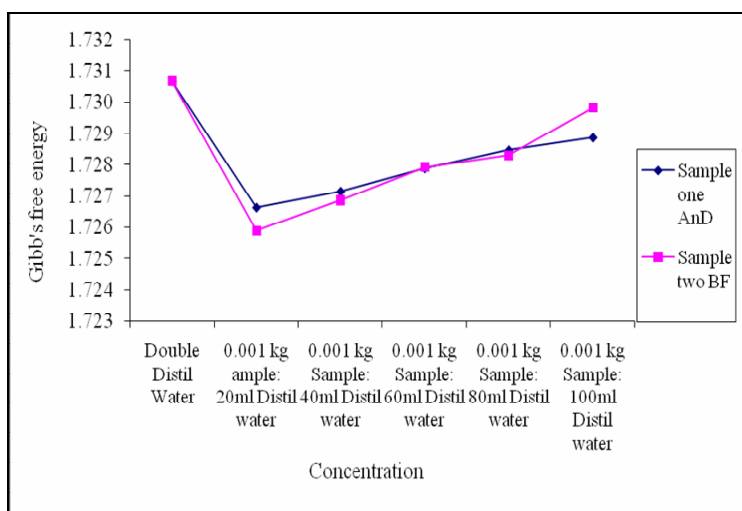


Figure 2. Gibb's energy of BF and AnD aqueous binary mixture

unlike molecules give negative. The value of intermolecular free length follows the same trend and figure 1 and figure 2. Weak interaction between unlike molecules gives in general positive excess values where as dipole-dipole, dipole-induced dipole, charge transfer and hydrogen bonding between. Gibbs' free energy is positive and increases slowly. This is attributed to hydrogen bonding and charge transfer between the molecules of the mixture. As the mixture consists of polar and non-polar liquids, in addition to dipole-dipole interactions there is a dipole-induced dipole interaction.

Table 1. Comparisons of intermolecular free length and Gibb's free energy for BF and AnD. (in SI units)

S.No.	Sample	Concentration	Inter molecular free length $L_f \times 10^{-11}$	Gibb's free energy $G \times 10^{20}$
1	AnD Powder With Distil Water	Double Distil Water	2.3604	1.7307
		0.001 kg ample: 20ml Distil water	2.3337	1.7266
		0.001 kg Sample: 40ml Distil water	2.3371	1.7271
		0.001 kg Sample: 60ml Distil water	2.3419	1.7279
		0.001 kg Sample: 80ml Distil water	2.3458	1.7285
		0.001 kg Sample: 100ml Distil water	2.3485	1.7289
2	BF Fruit Pulp With Distil Water	Double Distil Water	2.3604	1.7307
		0.001 kg ample: 20ml Distil water	2.3288	1.7259
		0.001 kg Sample: 40ml Distil water	2.3352	1.7269
		0.001 kg Sample: 60ml Distil water	2.3421	1.7279
		0.001 kg Sample: 80ml Distil water	2.3446	1.7283
		0.001 kg Sample: 100ml Distil water	2.3548	1.7298

4. Conclusion

From the above study it is seen that there exists molecular association between the components of the binary mixture due to dipole-dipole, dipole-induced dipole, charge transfer and hydrogen bonding interactions, which varies with the change in the frequency of the ultrasonic wave. The presence of Saponin, flavonoid, reducing compound, free-anthraquinone, terpenoids and alkaloids in BF and AnD subjected to phytochemical screening suggest potential source for useful drugs and enhancer of health status to its users.

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