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

Sushil Phadke1,*, Bhakt Darshan Shrivastava2, S. K Ujle3, Ashutosh Mishra4 and N. Dagaonkar5
1, Department of Physics, Government Girls College Dhar, MP, India
2, Department of Physics, Government P.G. College Biora, MP, India
3, Department of Physics, Government P.G. College Jhabua, MP, India
4, School of studies in Physics, DAVV, Indore MP, India
5, Department of Physics, Government P.G. College Dhar, MP, India

Email: sushilphadke5@gmail.com

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 thermodynamical 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 gonorrhea, 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.

![Figure 1. Intermolecular free length of BF and AnD aqueous binary mixture](image-url)
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 $G_{X10}$ |
|-------|---------------------------------|--------------------------------|-----------------------------------------------|--------------------------|
| 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.

Acknowledgment
One of the authors B.D.Shrivastava is highly thankful to University Grants Commission, New Delhi for awarding a Project. Our sincere thanks to Dr. S. Alawa Principal Govt. P.G. College, Dhar (MP) and Dr. S. N. Mandloi Principal Govt. Girls College, Dhar (MP) for providing lab facility and maximum cooperation.

References
[1] Sumathi T and Maheswari U 2009 *Ind. J. Pure Appl. Phys.* **47** 782.
[2] Rama Rao G V. 2004 *Ind. J. Pure Appl. Phys.* **42** 820.
[3] Narendra K. 2010 *E-Journal of Chemistry* **7** 927.
[4] Ali A and Nain A K. 2001 *Ind. J. Pure Appl. Phys.* **39** 421.
[5] Ali Anwar 2004 *J. Chin. Chem. Soc.* **51** 477.
[6] Tadkalkar Alka P 2012 *Archives of Phys. Res.* **3** 287.
[7] Ali A, Abida A K Nain and Hyder S 2003 *J Sol Chem.* **32** 865.
[8] Sofowara. A 1993. *Spectrum books ltd.*, Ibadan, Nigeria Pp 289 -300.
[9] Ferrara L 2005, *Ingredients alimentary* **4** 13.
[10] Phadke S., Shrivastava B.D. & .Mishra A 2009 *Ultra Scientist of Physical Sciences* **21** 499.
[11] Ujle S. K., Phadke S., Shrivastava B.D., Mishra A., Dagaonkar N., *Manuscript No. ISCA-ISC-2012-15Phys-17*. 