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Acoustic Studies of Aqueous Solution of *Adansonia Digitata* (AnD)

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Abstract

The aim was to measure Densities, Viscosities, surface tension and ultrasonic velocity sound in aqueous solution of AnD (Adansonia digitata) powder at different concentration on room temperature 306K. Natural samples were collected from Mandu Dhar District of MP India for this study. From these experimental data, thermodynamic and acoustical parameters were calculated and the results have been explained on the basis of molecular interaction occurring in the solution. A good to excellent correlation between a given parameter and concentration is observed systems studied. These findings could play a key role to develop the understanding in natural healthy product. Characterization of the sample material was done by scanning electron microscope.

Keywords: Acoustical properties, Densities, Viscosities, Surface Tension and ultrasonic velocity, Adasonia digitata (AnD), scanning electron microscope.

Introduction

The AnD (*Adansonia digitata*) fruit, leaves, and flowers are very important in terms of their nutritional value. Both the fruit and leaves are high in vitamin C[1]. The seed and flower are high in protein, and the kernel contains edible oil. Fruits are commonly seen in markets of Mandu District Dhar MP India. Young sprouts are consumed as a vegetable but are considered to be a famine food. The various parts of the baobab AnD are used to treat a large number of ailments. Nearly every part of the tree has some medicinal value. A few include: powered bark mixed with porridge for malaria; the pulp of the fruit is mixed with honey and is used for coughing; the leaves are used for diarrhoea, fever, inflammation, kidney and bladder diseases, blood clearing, and asthma; the leaves also serve as emollients and are used to help extract guinea worm; the fruits and seeds are used for dysentery, fever, haemoptysis and diarrhoea; dry powered roots are prepared as a mash for malaria; and gum from the bark is used for cleaning sores. Nondestructive testing[2] (NDT) is a wide group of analysis techniques used in science and industry to evaluate the properties of a material, component or system without causing damage The density, viscosity, surface tension was measured by Pyknometer, Ostwald's viscometer, and Traube's stalagmometer (drop pipette)[3]. We used ultrasonic as NDT technique to measured ultrasonic velocity[4]. Ultrasonic velocity were measured by Ultrasonic Interferometer of Mittal enterprises, New Delhi. Characterization of the samples was made by scanning electron microscope (SEM)[5] Model JEOL JSM5400 because microscope examination of the fruit pulp of AnD shows whether a material fibrous, spongy or smooth.

Description of *Adansonia digitata* AnD tree: *Adansonia digitata*[6] is characterized by an unusual, swollen, relatively short, bottle shaped trunk (about 15 m in height) in which spongy fibers store water for the dry season. For this reason, it is also called "bottle tree". The mature circumference can exceed 20 m; the diameter at chest height is about 10 m. The crown is rounded and shows a stiff branching habit. The tree has an extensive lateral root system, which pro-duces tubers at the end. African baobab is a very long-living tree. It normally lives for about 500 years, but it is believed that some trees are up to 5000 years old.

Figure-1
Fruit pulp of dried AnD

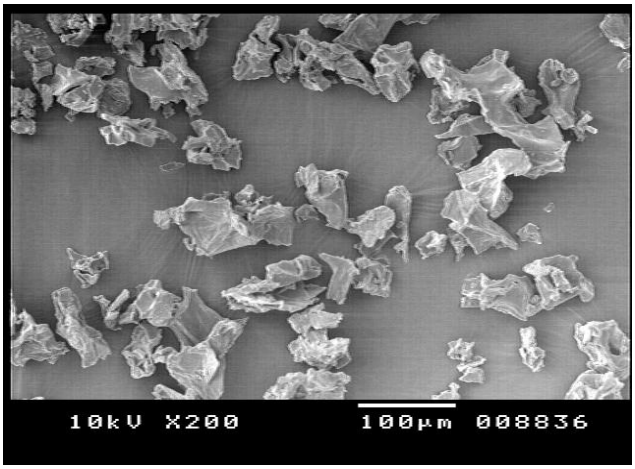

Figure-2
SEM picture of dried fruit pulp of AnD

The tree sheds its leaves during the dry season, which can last most of the year depending on the climate zone. Leaves are digitate, normally having 5 leaflets when mature. The leaflets have entire margins and are elliptic to obovate-elliptic, with acuminate apex and a decurrently base. Mature leaf size may reach a diameter of 20 cm. The flowers bloom during the wet season and the dry season as well. They are very large and suspended on long peduncles. The fruit is bottle or cu-cumber shaped and develops 5-6 months after florescence. It has a woody outer shell, 7.5-54 cm long x 7.5-20 cm wide, covered by velvety yellowish, sometimes greenish hairs. The internal fruit pulp is split into mealy agglomerates that enclose several Reni form seeds (approximately 10 mm long)[7].

Material and Method

The AnD fruit was collected from the markets of Mandu District Dhar MP India. The dried AnD fruit pulp powder figure 1 was taken for the preparation of aqueous and ethanolic solution. We used Distil water prepared in our laboratory and 99 % AR grade ethanol of LOBO make. All the measurements were taken at room temperature 308K.

Table-1
Analysis of Baobab Fruit Pulp (mg/100 g)[8]

Protein	2.3
Lipids	0.27
Soluble and insoluble Fibers	52.0
Carbohydrates	75.6
Ascorbic acid (Vitamin C)	280-300 (to compare: 51 in oranges)
Calcium	293 (to compare: 125 in milk)
Potassium	2.31
Phosphorus	96-118

Theory and calculation: Isentropic compressibility, acoustic impedance and Intermolecular free length can be calculated from the ultrasonic velocity (U) and the density of the medium (ρ) using the equations[9] as:

$\beta = 1/U^2\rho$ (1)

$Z = U\rho$ (2)

$L_f = K\sqrt{\beta}$ (3)

Where K Jacobson's constant that depends on temperature[10] and is given by $K = (93.875+0.375T) \times 10^{-8}$; T being the absolute temperature.

Result and Discussion

The table 2 shows the measured values of density, ultrasonic velocity, viscosity and surface tension of AnD fruit powder at different concentrations in distil water and ethanol 99% AR grade. All the measurement were taken at room temperature 308K.The values of density, ultrasonic velocity, viscosity and surface tension decreases with the dilution of And fruit powder in both distil water and ethanol 99% AR grade.

Table-2
Measured values of density, ultrasonic velocity, viscosity and surface tension at different concentrations on room temperature 308K in MKS units

S.No.	Sample	concentration	Density $\rho \times 10^3$	Ultrasonic Velocity U	Viscosity	Surface Tension
1	AnD Powder With Distil Water	Double Distil Water	0.9937	1517	0.653	6.69
		0.001 kg ample: 20ml Distil water	0.1001	1529.67	0.201	8.89
		0.001 kg Sample: 40ml Distil water	0.9995	1527.84	0.181	8.68
		0.001 kg Sample: 60ml Distil water	0.9987	1525.13	0.093	8.4
		0.001 kg Sample: 80ml Distil water	0.9962	1524.53	0.089	7.6
		0.001 kg Sample: 100ml Distil water	0.9951	1523.64	0.081	7.4
2	AnD powder With Ethanol 99%AR grade	Ethanol 99%AR grade	0.775	1234.8	0.073	2.4
		0.001 kg Sample: 20ml Ethanol	0.7959	1181.48	0.075	2.73
		0.001 kg Sample: 40ml Ethanol	0.7847	1163.43	0.070	2.66
		0.001 kg Sample: 60ml Ethanol	0.7821	1144.98	0.064	2.59
		0.001 kg Sample: 80ml Ethanol	0.7802	1123.38	0.058	2.53
		0.001 kg Sample: 100ml Ethanol	0.7694	1108.57	0.055	2.48

Table-3
Calculated values of isentropic compressibility, acoustic impedance and intermolecular free length at different concentrations on room temperature 308K in MKS units

S. No.	Sample	concentration	Isentropic Compressibility β_s x 10^{-10}	Acoustic Impedance Z x 10^6	Inter molecular free length Lf x 10^{-11}
SAMPLE 1	AnD Powder With Distil Water	Double Distil Water	4.3729	1.5074	4.394
		0.001 gram Sample: 20ml Distil water	4.2741	1.5295	4.3441
		0.001 gram Sample: 40ml Distil water	4.2861	1.5271	4.3502
		0.001 gram Sample: 60ml Distil water	4.3048	1.5231	4.3597
		0.001 gram Sample: 80ml Distil water	4.3189	1.5187	4.3669
		0.001 gram Sample: 100ml Distil water	4.3288	1.5162	4.3718
SAMPLE 2	AnD powder With Ethanol 99%AR grade	Ethanol 99%AR grade	8.4626	0.957	6.1127
		0.001 gram Sample: 20ml Ethanol	9.0009	0.9403	6.3041
		0.001 gram Sample: 40ml Ethanol	9.4149	0.9129	6.4474
		0.001 gram Sample: 60ml Ethanol	9.7531	0.8955	6.5622
		0.001 gram Sample: 80ml Ethanol	10.1564	0.8765	6.6965
		0.001 gram Sample: 100ml Ethanol	10.576	0.8529	6.8334

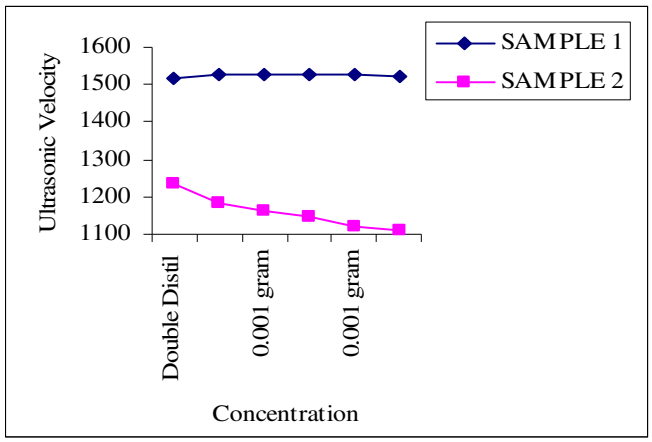

Figure-3
Variations of ultrasonic velocity with concentration

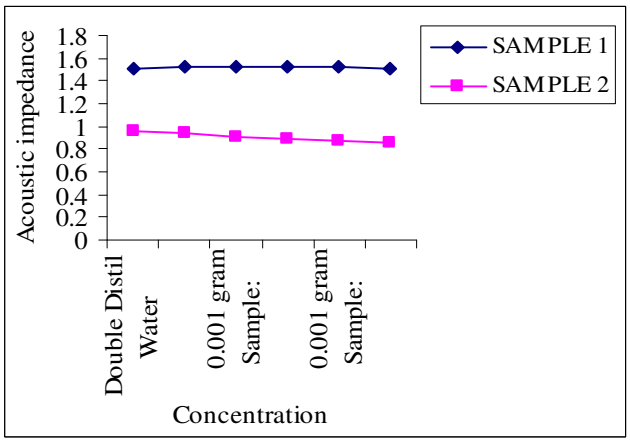

Figure-5
Variations of acoustic impedance with concentration

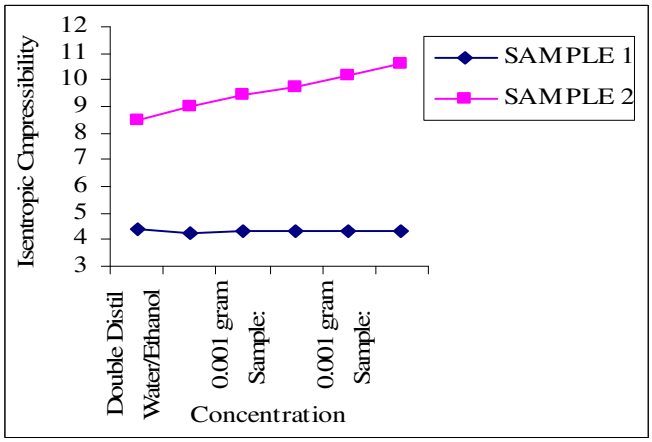

Figure-4
Variations of isentropic compressibility with concentration

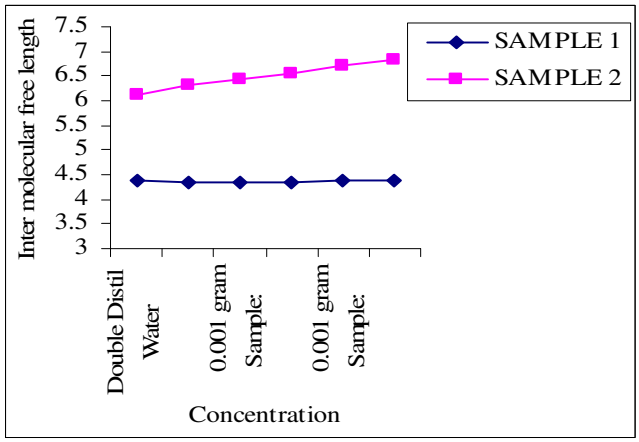

Figure-6
Variations of inter molecular free length with concentration.

According the relation between ultrasonic velocity and density the values of isentropic compressibility, acoustic impedance and intermolecular free length were also changed with the concentration at room temperature 308K, showed in table 3. The values of isentropic compressibility and intermolecular free length were nearly same and increases in negative in tenth power in MKS units with the concentration but the values of acoustic impedance decreases in tenth power MKS units showed in table 3. All the variations were showed in figure 3 to figure 6. The SEM picture taken at 10kv x 200 and 100μm by scanning electron microscope was shown in figure 2.

Conclusion

The isentropic compressibility, acoustic impedance and intermolecular free length depend on ultrasonic velocity and density. The force between atoms increases with the decreases of intermolecular free length as dilution of sample increases. The SEM result shows the AnD fruit pulp powder was smooth and spongy.

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