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Estimation of Mineral Content in Vegetable Extraction by Ultrasonic Technique

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ABSTRACT: *Vegetables are very essential for us in improving our nutritional level. They are acting as an herbal medicine in an unfathomable way in our daily life. In my research the select vegetables are Potato, Beetroot which are all rich in vitamin c and Potassium helps to balance fluids and minerals in our body and maintain a normal blood pressure. Estimation of mineral contents and vitamins has been done by measuring the ultrasonic velocity, density, adiabatic compressibility. Further the experimental vales are confirmed by FTIR.*

KEYWORDS: *Ultrasonic velocity, density, adiabatic compressibility, Interferometer*

I. INTRODUCTION

Ultrasonic offer the most exciting and fascinating field of scientific research among the researcher. The word 'ULTRASONIC' means ultra-beyond, sonic-sound. Since the ultrasonic and other related thermo acoustic parameters provide useful information regarding the molecular interaction, structure of molecules[1-2]etc. Ultrasonic study of liquid and liquid mixture has gained much importance during the last two decades in assessing the nature of molecular interaction and investigating the physiochemical behavior of system[3-4].

LIQUID STATE PHYSICS : There are two fundamental problems in discussing thestructure of liquids. The first is that of understanding the nature of molecular interaction. In general terms, it can be said that the forces are repulsive for small molecular separations, but a detailed knowledge is necessary for the understanding of liquid properties. The second fundamental problem is that of relating the bulk or macroscopic properties of a system to the microscopic or molecular properties and in particular to the potential energy function which describes the way in which an isolated describes the way in which an isolated pair of the molecules interacts[5].

Peculiarities of Liquid State : The most obvious resemblance between liquids and gases is their lack of rigidity. As such, neither of them offers a permanent resistance to a shearing stress. An immediate consequence of this is that, neither liquid nor a gas possesses a shape of its own; both assume the shape of the container. Every solid on the other hand possesses a definite form and will always offer a resistance to shearing stress. Between liquids and solids, the most prominent similarity is that both possess cohesion, which enables them to maintain a free surface, whereas a gas always fills any container. The next and less fundamental property common to liquids and solids is their relative incompressibility compared to gases. While the compressibility of solid is usually of the order of 10^{-6} atm^{-1}, those of liquids are only slightly larger, 10^{-5} $atm.^{-1}$. But the compressibility of a gas, which is roughly equal to the reciprocal of the pressure, (at a pressure of one atmosphere) is about 10^{-5} times as great as that of a liquid. Closely allied to this similarity between liquids and solids, is their similarity in density. The density change which takes place when a solid melts is usually of the order of 10 to 15 percent, but on vaporization, the density decreases by 100 to 1000.

From these simple facts, considerable information can be obtained about the nature of the molecular arrangement in the liquids. From the density considerations, for example, the mean distance between the molecules (the word 'molecule' is used for simplicity to indicate "atom, molecule or ion') can be calculated. In the liquids, there is a little space about 5% of the molecular diameter between the molecules in a gas, the space between the molecules is about six times the molecular diameter. Forces between molecules are of short range and act through a distance of only two to their molecular diameter. In a gas, these forces are of little importance and any regular arrangement of the molecules will be destroyed by the thermal motion of the molecules. Thus, the usual assumption that the molecule of a gas are arranged in random is justified.

Fourier Transform Infrared Spectrometry (FTIR) : FTIR stands for Fourier Transform Infrared, the preferred method of infrared spectroscopy. In infrared spectroscopy, IR radiation is passed through a sample. Some of the infrared radiation is absorbed by the sample and some of it is passed through (transmitted). The resulting spectrum represents the molecular absorption and transmission, creating a molecular fingerprint of the sample. Like a fingerprint no two unique molecular structures produce the same infrared spectrum. This makes infrared spectroscopy useful for several types of analysis[6].

Uses of FTIR[7]

- It can identify unknown materials.
- It can determine the quality or consistency of a sample.
- It can determine the amount of components in a mixture.

II. EXPERIMENTAL TECHNIQUE

ULTRASONIC INTERFEROMETER : Ultrasonic interferometer is a simple device which yields accurate and consistent data, from which one can determine the velocity of ultrasonic sound in a liquid medium.

Ultrasonic sound refers to sound pressure with a frequency greater than the human audible range (20Hz to 20 KHz). When an ultrasonic wave propagates through a medium, the molecules in that medium vibrate over very short distance in a direction parallel to the longitudinal wave. During this vibration, momentum is transferred among molecules. This causes the wave to pass through the medium.

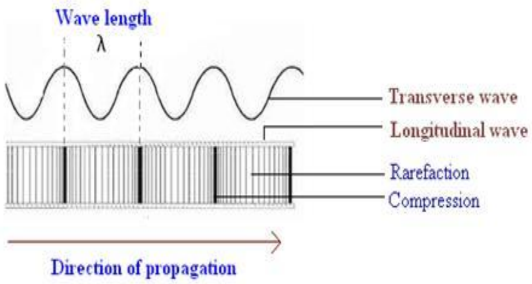

Figure 1

The schematic diagram of an ultrasonic interferometer is shown in the figure.

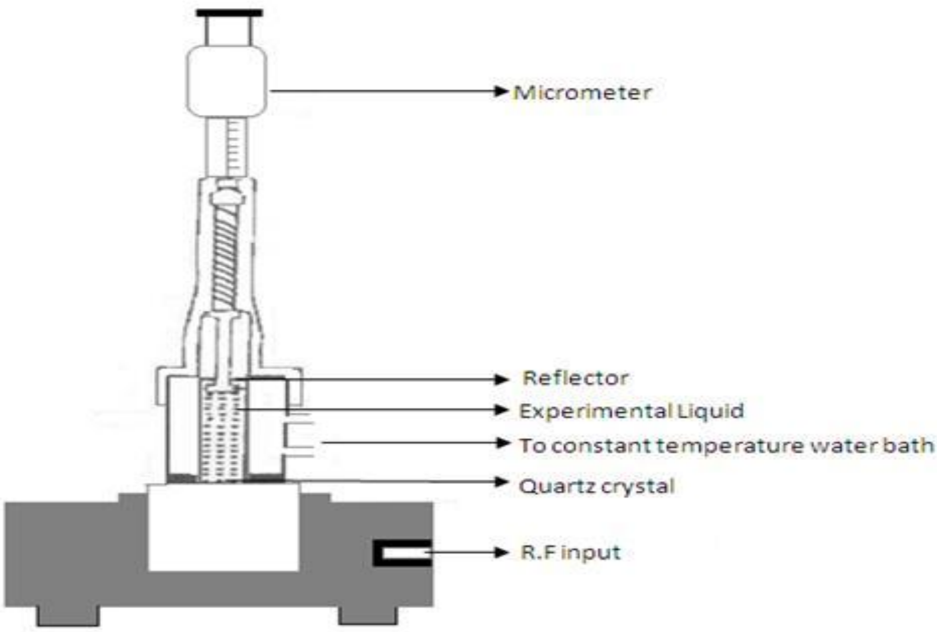

Figure 2

Figure 3

In an ultrasonic interferometer, the ultrasonic waves are produced by the piezoelectric method. In a fixed frequency variable path interferometer, the wavelength of the sound in an experimental liquid medium is measured, and from this one can calculate its velocity through that medium. The apparatus consists of an ultrasonic cell, which is a double walled brass cell with chromium plated surfaces having a capacity of 10ml. The double wall allows water circulation around the experimental medium to maintain it at a known constant temperature.

The micrometer scale is marked in units of 0.01mm and has an overall length of 25mm. Ultrasonic waves of known frequency are produced by a quartz crystal which is fixed at the bottom of the cell. There is a movable metallic plate parallel to the quartz plate, which reflects the waves. The waves interfere with their reflections, and if the separation between the plates is exactly an integer multiple of half-wavelengths of sound, standing waves are produced in the liquid medium. Under these circumstances, acoustic resonance occurs. The resonant waves are a maximum in amplitude, causing a corresponding maximum in the anode current of the piezoelectric generator.

Ifthe distance is increased or decreased by exactly one half of the wavelength ($\lambda/2$) or an integer multiple of one half wavelength, the anode current again becomes maximum. If d is the separation between successive adjacent maxima of anode current then,

$$d=\lambda/2 \qquad (1)$$

We have, the velocity (***v***) of a wave is related to its wavelength (***λ***) by the relation,

$$v=\lambda f \qquad (2)$$

Where**, f** is the frequency of the wave. Then,

$$v=\lambda f=2df \qquad (3)$$

The velocity of ultrasound is determined principally by the compressibility of the material of the medium. For a medium with high compressibility, the velocity will be less. Adiabatic compressibility of a fluid is a measure of the relative volume change of the fluid as a response to a pressure change. Compressibility is the reciprocal of bulk modulus, and is usually denoted by the Greek word beta (β).The adiabatic compressibility of the material of the sample can be calculated using the equation,

$$\beta= 1/\rho v^2 \qquad (4)$$

Where ρ is the density of the material of the medium and v is the velocity of the sound wave through that medium

. Use of vitamin 'C'[9]

- It is required for the proper development and functions of many parts of the body.
- It plays an important role in maintaining proper immune functions.

3.2. Use of potassium mineral[10]

- It helps to balance fluids and minerals in our body.
- It maintains a normal blood pressure.
- It helps us to muscle contract and the normal nerves function.

III. RESULT AND DISCUSSION

Name of the vegetable juice	Ultrasonic velocity(m/s)	Density(kg/m^3)	Compressibility(cm^2/dynes))
Potato	1566.22	1.0061	4.0518
Beetroot	1595.6	1.0703	3.8981

Vegetables	K(mg)	Mg(mg)	Ca(mg)	Na(mg)	Fe(mg)	Mn(mg)	Cu(mg)	Zn(mg)
Beetroot	325(9%)	20(5%)	14(1.5%)	65(1%)	0.67(3%)	0.277(1.5%)	0.063(4%)	0.3(0.5%)
Potato	421(12%)	48(6%)	26(1%)	17(0%)	1.87(4%)	0.379(1.5%)	0.204(2%)	0.62(0%)

VITAMIN AND MINERAL CONTENT OF POTATO AND BEETROOT[8]

IV. CONCLUSION:

From the tables 1&2 it is observed that mineral content Potasium[1,2] takes a vital role in the changes taken place in the value of Ultrasonic velocity value. Because even though both the samples potato and beetroot are vitamin C,the values of Ultrasonic velocity varies slightly as in the value of potassium.so it is found that Ultrasonic technique is highly useful in estimating of mineral content of fruit samples.And it can be confirmed through FTIR graphs.

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