STUDY IN ACOUSTICAL PROPERTIES OF GLUCOSE WITH BIOCHEMIC SALTS AT DIFFERENT CONCENTRATIONS IN AQUEOUS SOLUTION

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Abstract:

In the present work, the acoustical parameters of aqueous solution of glucose and bio-chemic salts are carried out by measuring ultrasonic velocity at varying concentrations. The present analysis reveals that the intermolecular interactions of glucose with bio-chemic salts are continuously varying due to the structural transformations in the solution. The strength of intermolecular interactions of bio-chemic salt with glucose is $Fe_3(PO_4)_2$ < $Ca_3(PO_4)_2$ < NaCl < KCl < Na_2SO_4. This indicates that *Natrum Sulf* (Na_2SO_4) could be valuable remedy for diabetic patients.

Keywords: Bio-chemic salts, glucose, ultrasonic, variable concentartions

Introduction: Ultrasonic waves, highly energetic waves with frequency above 20,000Hz (20 KHz), have received considerable attention due to their applications like ultrasonic flaw detection, cutting and matching of hard materials, ultrasonic soldering and welding, measurement of flow devices, applications in medicine, communication. Thus, these have found wider relevance in the fields of medicinal, pharmaceutical, medical, physics and in almost every branch of basic sciences. Recently, ultrasonic has been used to study structure, intermolecular interactions and properties of matter. According to one school of thought, at present, sound velocity measurements are the only workable way to obtain trustworthy adiabatic compressibility values of molten salts and their mixtures at elevated temperatures [1-4].

There exists intimate relationship between ultrasonic velocity and chemical or structural characteristic of a molecule of liquid, in recent year, determination of ultrasonic velocity and absorption coefficient have furnished method for studying molecular and structural properties in liquid. Ultrasonic velocity gives properties of basic importance and sound velocity in molecular theory of liquid. Literature survey reveals that ultrasonic study of electrolyte solution with variation of ultrasonic velocity with ion concentration can be a useful tool for determination of extent of intermolecular interaction[1-6]. The extent of lowering of compressibility and increase in velocity with reference to that of water (as a reference) are proportional to number of ions existing in the medium. Structural interactions with ordered molecules and organic solvent molecule are reflected by properties like partial molar volume and adiabatic compressibility. Ultrasonic velocity measurement of aqueous glucose solution of different concentration and different carbohydrate bio-chemic salt solution of variable concentration measured at room temperature were studied in present analysis to determine interactions of glucose with bio-chemic salts.

Experimental Section: Ultrasonic velocity and density of double distilled water, aqueous glucose solutions of varying concentrations and aqueous solutions of glucose and bio-chemic salts were determined by ultrasonic interferometer (Mittal Enterprises) and digital dnsitometer (Anton Parr Lab). The standard procedure mentioned in literature was used throughout the study [5-9].

Results and discussions: The different acoustical parameters were calculated using the following formulae [1-6]:

The adiabatic compressibility of solvent (B_0) = $(U_0^2 d_0)^{-1}$

Adiabatic compressibility of solution (B_s) = $(U_s^2 d_s)^{-1}$

Apparent molar adiabatic compressibility of solution was determined respectively from density ds and adiabatic compressibility of Bs of solution using equation.

$$\Phi_{K(s)} = \frac{[10^3(B_s d_0 - B_0 d_s)]}{m.d_s\, d_0} + \frac{B_s M}{d_s}$$

Where,

B_0 = Adiabatic compressibility of solvent, B_s = Adiabatic compressibility of solution (Pa^{-1}), U_0= Ultrasonic velocity of solvent, d_0= Density of solvent, U_s= Ultrasonic velocity of solution, d_s = Density of solution, d_0= Density of solvent, m= Molality of solution, M= Molecular weight of solute, and $\Phi k_{(s)}$ is in $m^3\ mol^{-1}\ Pa^{-1}$.

Apparent molar compressibilities for different solutions:

Room temp = 31^oC, d_0 = 996.29 kgm^{-3}, U_0 = 1494 ms^{-1}

Sr.no.	Conc. Of Glucose (m)	$\Phi K_{(s)} \times 10^{-10}$ ($m^3 mol^{-1} Pa^{-1}$)					
		Glucose	Glucose + NaCl	Glucose + Na_2SO_4	Glucose + KCl	Glucose + $Fe_3(PO_4)_2$	Glucose + $Ca_3(PO_4)_2$
1	0.010	-450	-7.7	-450	17.7	-21	-7.4
2	0.009	-450	36.0	428	-7.2	-8	-5.5
3	0.007	-500	16.7	-39	-27.0	-15	-15.0
4	0.005	-640	-43.0	-27	33.9	-13	58.4
5	0.003	-900	119.0	985	-290.0	-270	-57.0
6	0.001	-1500	-270.0	-250	609.0	-82	-92.0

The acoustical study shows that there is no linear variation of Ultrasonic velocity and adiabatic compressibility with increase in concentration of glucose in aqueous solution. This indicates strong intermolecular interactions which are changing with concentration of glucose. The apparent molal adiabatic compressibility ($\Phi K_{(s)}$) is negative at all concentrations of glucose in the solution. This indicates that the solutions are very less compressible due to strong solute-solvent interaction leading to a more closely packed structure in the solution with increase in concentration of glucose [5-9].

The aqueous solutions containing glucose and bio-chemic salt also show non-linear variation in ultrasonic velocity, adiabatic compressibility and apparent molal adiabatic compressibility with increase in concentration of bio-chemic salt. This might be due to continuous change in structural arrangement, solute-solvent interaction, hydrogen bonding complex formation and dipole-dipole interactions [7-9].

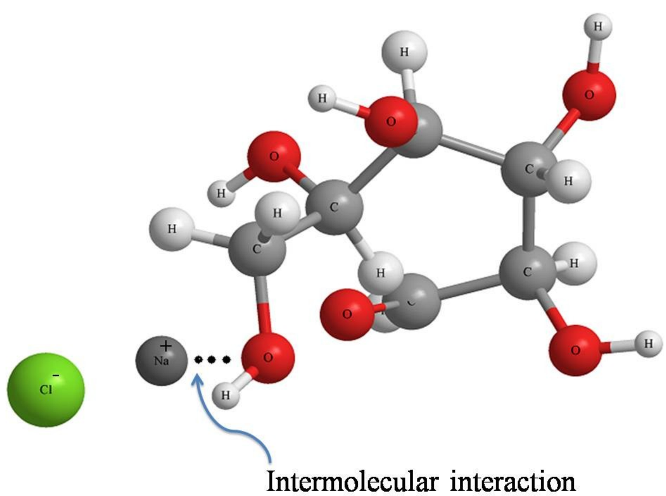

Figure 1. Plausible intermolecular interaction between NaCl and glucose molecule.

In the above figure, we have depicted the solute-solute intermolecular interactions (for simplicity, the water molecules have been omitted).

Conclusion

In case of glucose-Na_2SO_4 solution, the concentration ratio 0.003:0.007, the $\Phi K_{(s)}$ value is positive and highest indicating more compressibility of solution. This might be due to weaker water-glucose interaction and very strong glucose-Na_2SO_4 interaction. This reveals that Na_2SO_4 could be a more valuable remedy to control glucose level in diabetic patients. The increasing order of glucose level controlling power in the present study is $Fe_3(PO_4)_2$ < $Ca_3(PO_4)_2$ < NaCl < KCl < Na_2SO_4.

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