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Ultrasonic Characterization on Glucose in Aqueous Vitamin C Solution

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Research Article

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ABSTRACT

Glucose and Vitamin C both are important for human body as well as plants and all living creature. The value of velocity, density of glucose at different concentration 0.02 M-0.2 M in the solution aqueous vitamin C solution of 0.2 M concentration at different temperature 283.15 K-298.15 K has been measured. By using the velocity and density other acoustical, thermodynamical and volumetric parameter also calculated like free length (L_f), Wada's constant (W), Rao's constant (R), internal pressure (π_i), viscosity (η), apparent molar volume (V_ψ), adiabatic compressibility (β), acoustic impedance (Z), Relative Association (R_A) and relaxation strength (r). Variation in this all parameter with respect to change in molality and temperature exhibit the existence of intermolecular interaction. And this all parameter shows the solute-solvent interaction.

Keywords: Carbohydrates; Vitamin C; Acoustical parameter; Volumetric parameter; Thermodynamical parameter; Molecular interaction

INTRODUCTION

Carbohydrates are the most important source of energy in the living creature and it is mostly consumed by the humans. It performs an important role in humans to regulating of living throughout biologically based cycle [1]. And carbohydrates are the building blocks in living creature. Its molecules are the saccharides and they play a major role not only for livings but also in chemical process. Mono and Di-Saccharides are called to improve the form of water so it is behaved as a steadying agent for enzymes and protein [2]. Glucose is the example of saccharides and it is the simplest form of carbohydrate. Glucose is a simplest form of sugar which has mol. formula $C_6H_{12}O_6$. The morpheme "-ose" is chemical classifier which indicates that belongs to a carbohydrates group. It has 6 carbon atoms and it is classified as a hexose, a sub group of monosaccharides. Glucose is made in plant during the photosynthesis process from water, carbon dioxide, in the presence of sunlight. Glucose is an omnipresent fuel in biology. It is boost up the energy level in the most organisms like bacteria, humans, etc. Glucose is the human body's key source of energy [3]. Glucose presents in the human blood and it gives energy to the cells for metabolism. In blood, Glucose contains intercellular fluid, Interstitial Fluids (ISF), tears, saliva and urine [4]. Glucose is the main resource of energy for the brain and other cells; hence its obtainability affects psychological process. When it is low, psychological process to required mental efforts like self-control, wrong decision making is harmed [4].

As much as carbohydrate/glucose/saccharides important for body likewise vitamins also essential for living organisms. Carbohydrates/Glucose gives energy to the cell like that vitamins mandatory to balance the normal cellular and metabolic function of humans and animals body and it is a wide group of organic compounds. Vitamins are natural constituent of food and well-balanced diet supplies of all the required vitamins [5]. Vitamins are a well-known group of compounds that are essential for human health. Organic chemical compound is called vitamins. Vitamins are as so many like vitamins A, B, B2, B5, B6, B9, B12, C (Ascorbic Acid), D and E. Ascorbic acid is a vitamin C. It is a colorless and dissolvable vitamin. The structure of L-ascorbic acid was first discovered by scientist Norman Haworth and for that he got a noble price in 1937 [6]. Ascorbic acid is essential to development of brain of unborn baby. It is also playing an important role in the health of adults like; boosting immunity power, repairs damage tissues etc. while its deficiency can cause major effect on the human brain progress, which cannot be remediable after birth and vitamin C supplementation [7].

Other than this all information we can also find the other parameters by using ultrasonic technique. The investigation of molecular nature and physic-chemical behavior of various liquid and their mixtures can be assessed by using ultrasonic characterization [8]. Ultrasonic method generally involves measuring the ultrasonic velocity of pure solution or mixture at different temperature and concentration [9]. Ultrasonic studies helps to characterizing acoustical, volumetric and elastic and thermodynamics behavior of various liquid mixtures. Ultrasonic waves propagate with frequency above 20 kHz [10]. So, by investigating we can find other acoustical, thermodynamic and volumetric parameters like thermal conductivity, Enthalpy, Specific heat ratio, adiabatic compressibility, Viscosity, Surface tension etc. and by using ultrasonic we can also find the inter molecular interaction between saccharides and vitamins at different temperature and concentration.

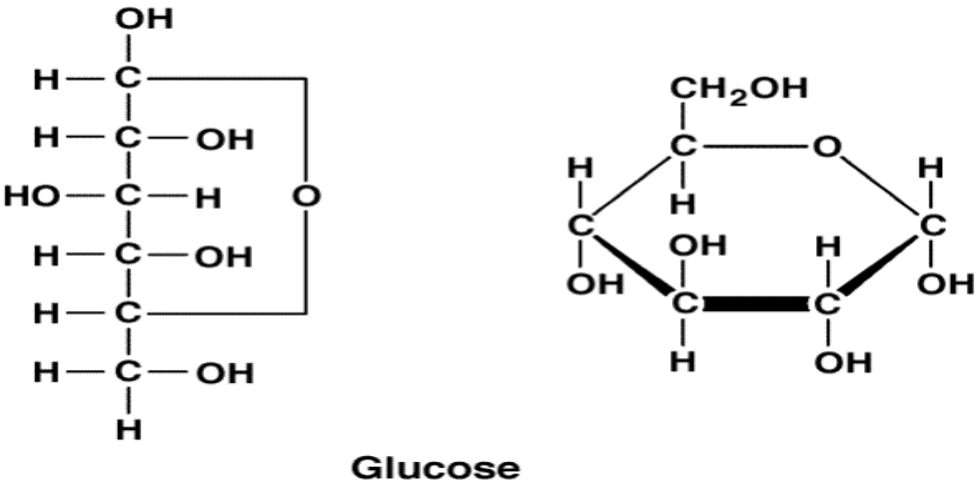
So, presented work is focused to understand the interaction of glucose and vitamins at different concentration 0.02-0.2 mol/kg and different temperature 283.15 K to 298.15 K. Glucose is one of the compounds produced in plants after the disintegration of carbohydrates into mono and disaccharides. After the whole process of citric acid cycle and oxidative phosphorylation, the oxidation of glucose eventually form CO_2 and water, through which most

energy release in the form of ATP [3]. The interaction of glucose and vitamin C regulates blood sugar level in human body.

MATERIALS AND METHODS

AR grade chemicals such as Glucose (CAS no.: 50-99-7) those have mol. formula $C_6H_{12}O_6$ with mol. weight 180.16 g/mol and Ascorbic acid known as vitamin C (CAS no.: 50-81-7) having molecular weight is 176.12 g/mol, were access from Himedia Laboratory Private Limited, Mumbai. All compounds were used without processing. The concentration (0.02-0.2 mol/kg) of ascorbic acid in 0.2 M aq. glucose solution was different by weight. All the beakers and other equipment's were clean with double distilled water and acetone shown in Figure 1. All the equipment's dried before use [11].

Figure 1. Structure of glucose.



Defining relation

Ultrasonic Velocity was deliberate by using pulse Echo overlap technique in 2 MHz. The interferometer was stuffed with the test solution and the temperature of the interferometer was maintained with the help of thermostat which circulate the water around the cell of interferometer [7]. From experimental value we can calculate the velocity, density of given solution (Table 1). But also, we can find the other volumetric, acoustical and thermodynamical parameter by using following standard formulas;

- Adiabatic compressibility(β) = $\frac{1}{U^2\rho}$
- Acoustic Impedance(Z) = U ρ
- Relative Association (R_A) = {(ρ/ρ_0)(U_0/U)$^{1/3}$}
- Internal Pressure (π_i) =$\{\frac{T*\alpha}{K_T}\}$, Where α is the Thermal Expansion Coefficient and K_T is the Isothermal Compressibility.
- Free Length (L_f) = K (β) $^{1/2}$, Where K is the Jacobian temperature dependent constant.
- Wada's constant(W) = $V_m\beta^{-1/7}$
- Rao's constant(R) = $V_mU^{1/3}$
- Viscosity(η) = (Meff × ρ^2)^1/3 × U^3/K× Ug^2

- Apparent molar volume(V_ψ) = $\{\frac{M}{\rho} - [\frac{1000(\rho-\rho_0)}{m\rho\rho_0}]\}$
- Relaxation Strength(r) = $\{1-(\frac{U}{U_\infty})^2\}$, Where U_∞ = 1600 m/s.

Table 1. Apparatus/Instruments used to complete the experimental work.

Sr. No.	Apparatus	Description	Supplier	Precision
1	Analog Velocity interferometer	Operates at 2 MHz Frequency (Model F-81)	Mittal Enterprises Pvt. Ltd., New Delhi	0.0001 m/s
2	Specific Gravity Density Bottle	Density of mixture analyzed perfectly	Kings group Mumbai, Maharashtra	± 2 × 10^{-2} kg/m^3
3	Digital Electronic Balance	Contech CA-34	Wensar Company	± 0.0001 gm
4	Thermostatic Water Bath	Regulating temperature of Water	Lab-Hosp instrumental Company Mumbai	± 1 K temperature

RESULTS AND DISCUSSION

The knowing of molecular interaction between a solute and solvent and the packing efficiency of solute within the structure of solvents have been studied in aqueous and mixed aq. solutions [12]. When the glucose is dissolved in water, the volume of solution is almost equal to the sum of volume of crystal sugar and water [13].

Ultrasonic velocity

The ultrasonic velocity of the water was measured at various temperatures (283.15 K, 288.15 K, 293.15 K and 298.15 K) and the calculated value given in Tables 2 and 3. And after equating the calculated value and literature value it observed that the result is almost equal to the literature data. The ultrasonic velocity of Glucose at different concentration 0.02 M-0.2 M in the solution aqueous vitamin C solution of 0.2 M concentration at different temperature 283.15 K-298.15 K were measured and given in Table 4. It is examining that temperature and concentration affect the ultrasonic wave in existing system (Glucose+Water+Vitamin C). The observed data shows that the ultrasonic velocity of the solution is rising with increase in molarity and temperature shown in Figure 2. So, by increasing carbohydrates concentration in the aqueous vitamin C solution the ultrasonic velocity increases [13]. It

is observed that molecular association is accountable for this alteration. This alliance is due to the Hydrogen bonding between solute and solvent molecules [10].

Table 2: Density and ultrasonic velocity of water at 283.15 K, 288.15 K, 293.15 K and 298.15 K temperature.

Temperature	Literature data		Current work data	
	Ultrasonic Velocity (U)	Density (ρ)	Ultrasonic Velocity (U)	Density (ρ)
K	meter/s	Kg/m^3	meter/s	Kg/m^3
283.15	1447.379	999.789	1447.427	999.700
288.15	1466.125	999.202	1466.032	999.103
293.15	1481.615	998.188	1481.496	998.200
298.15	1498.211	997.032	1498.101	997.000

Table 3. List of abbreviations shown in the below table.

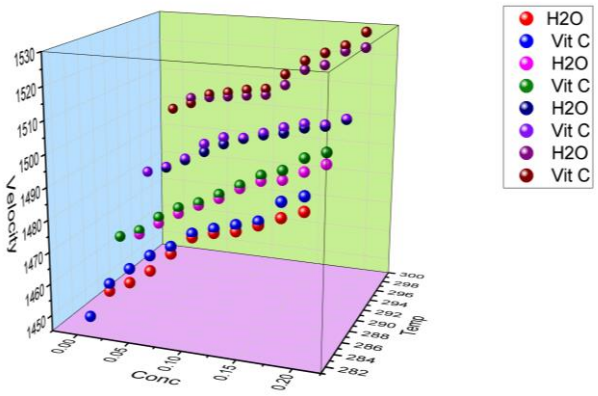
Short name	Abbreviations
kHz	Kilo Hertz
ATP	Adenosine Triphosphate
CAS	Chemical Abstract Service
M	Molal Concentration in mol./kg
MHz	Mega Hertz

Table 4. The value of velocity, density and specific heat at different concentration of glucose+0.2 M aqueous solution of vitamin C at different temperatures (282.15 K-298.15 K).

Conc.	Velocity(m/s)		Density (Kg/m³)		Free Length(m)	
	H_2O	Vitamin C	H_2O	Vitamin C	H_2O	Vitamin C
	283.15 K					
0	1447.4	1447.4	999.7	999.7	4.41237E-11	4.41237E-11
0.02	1456.6	1459.3	1007.736	1029.794	4.36707E-11	4.31294E-11
0.04	1460.2	1464.6	1009.1179	1030.112	4.3532E-11	4.29566E-11
0.06	1464.8	1469.6	1010.0545	1030.630	4.33747E-11	4.27991E-11
0.08	1471.6	1473.2	1010.878	1031.241	4.31741E-11	4.26813E-11
0.1	1476.9	1478.1	1011.5554	1032.397	4.29884E-11	4.25177E-11
0.12	1479.0	1480.4	1012.4389	1033.327	4.29075E-11	4.24332E-11
0.14	1480.3	1482.3	1012.9835	1034.097	4.2858E-11	4.23624E-11
0.16	1482.9	1484.1	1013.6875	1034.628	4.27683E-11	4.23002E-11
0.18	1485.9	1490.6	1014.3517	1035.451	4.26691E-11	4.20971E-11
0.2	1488.5	1493.2	1014.9694	1036.747	4.25822E-11	4.2005E-11
	288.15 K					
0	1466.0	1466.2	999.103	999.103	4.398E-11	4.398E-11
0.02	1467.6	1468.8	1004.0106	1025.456	4.38249E-11	4.33291E-11
0.04	1472.2	1474.3	1005.3395	1026.160	4.36657E-11	4.31618E-11
0.06	1476.8	1477.8	1006.5368	1027.206	4.35214E-11	4.3028E-11
0.08	1479.4	1480.2	1007.4775	1028.173	4.34011E-11	4.29389E-11
0.1	1482.3	1483.6	1008.5235	1028.989	4.32937E-11	4.28229E-11
0.12	1486.2	1487.2	1009.1221	1030.291	4.31673E-11	4.26928E-11
0.14	1489.2	1491.2	1010.076	1031.298	4.306E-11	4.25632E-11
0.16	1490.2	1493.2	1010.9904	1032.074	4.30117E-11	4.24845E-11
0.18	1493.4	1497.6	1011.5101	1033.087	4.29085E-11	4.23378E-11
0.2	1496.3	1500.0	1012.6943	1034.002	4.2798E-11	4.22525E-11
	293.15 K					
0	1481.4	1481.4	998.2000	998.2	4.39E-11	4.39423E-11
0.02	1483.6	1483.8	1001.794	1022.713	4.38012E-11	4.33451E-11
0.04	1486.8	1487.2	1002.878	1023.572	4.36833E-11	4.32278E-11
0.06	1490.2	1492.8	1003.717	1024.887	4.35654E-11	4.3038E-11
0.08	1493.4	1495.6	1005.798	1025.951	4.34265E-11	4.29352E-11
0.1	1495.8	1496.9	1006.307	1026.460	4.33464E-11	4.2913E-11
0.12	1497.6	1498.2	1007.391	1027.649	4.3271E-11	4.28252E-11
0.14	1498.8	1500.6	1008.368	1028.361	4.32154E-11	4.27418E-11
0.16	1501.0	1502.4	1009.617	1028.951	4.31242E-11	4.26785E-11

0.18	1502.2	1502.6	1010.661	1030.226	4.30687E-11	4.26464E-11
0.2	1504.9	1505.4	1011.104	1031.535	4.29808E-11	4.25514E-11
298.15 K						
0	1498.1	1498.1	997	997	4.38788E-11	4.38788E-11
0.02	1502.4	1500.6	998.8176	1019.743	4.37134E-11	4.33145E-11
0.04	1503.2	1504.2	999.6707	1020.412	4.36715E-11	4.31967E-11
0.06	1504.3	1505.4	1000.707	1021.607	4.36257E-11	4.3137E-11
0.08	1504.8	1506.8	1001.593	1022.893	4.35832E-11	4.30698E-11
0.1	1505.6	1507.6	1003.010	1023.897	4.35293E-11	4.30258E-11
0.12	1509.4	1513.1	1004.277	1024.966	4.33923E-11	4.28499E-11
0.14	1515.2	1518.6	1005.143	1025.760	4.32133E-11	4.26922E-11
0.16	1517.3	1521.4	1005.891	1026.738	4.31402E-11	4.25877E-11
0.18	1522.0	1523.8	1007.663	1027.466	4.29607E-11	4.24944E-11
0.2	1523.6	1528.6	1008.463	1028.451	4.28985E-11	4.23407E-11

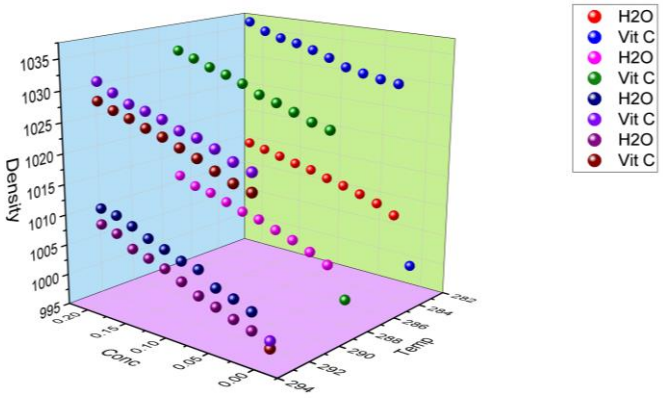
Figure 2. Ultrasonic velocity at different temperature and concentration. **Note:** (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C



Density

The density of water was measured at various temperatures 283.15 K, 288.15 K, 293.15 K and 298.15 K and calculated value given in Table 2. And after comparing the calculated value and literature value it observed that the result is almost equal to the density of water at literature data. Density of glucose at different concentration 0.02 M-0.2 M in the solution aqueous vitamin C solution at 0.2 M of concentration. The observed data shows that density of the solution is rising with increase in concentration of Glucose in the solution of aq. vitamin C at different temperature but the density is fall off with increases in temperature for same molarity depicted in Figure 3. The relationship between concentration and density for this particular is a linear one [3].

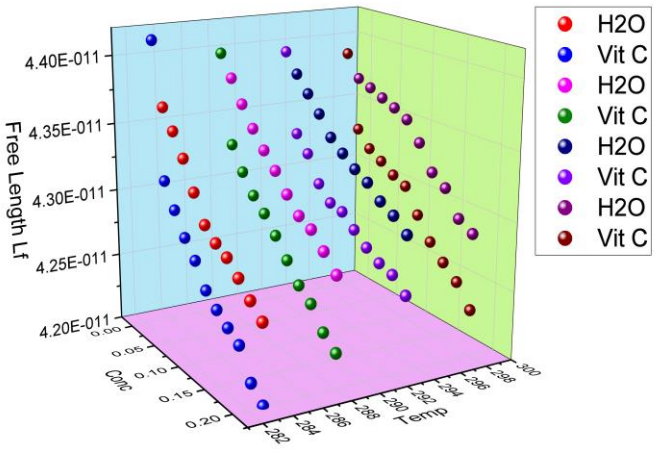
Figure 3. Density at different temperature and concentration. **Note:** (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C



Free length

Free length is a thermodynamical parameter because it is depending on the temperature i.e., Jacobian temperature dependent constant. The free length of the glucose and aqueous vitamin C solution at different concentration (0.02 M-0.2 M) at different temperature (283.15 K-298.15 K) is decrease with respect to increase in molarity and temperature that Figure 4 shows, because concentration of solute indicate that the intermolecular interaction between solute and solvent suggest the arrangement after adding the solute and increase in temperature shows that the spacing in the structure [14].

Figure 4. Free length at different temperature and concentration. **Note:** (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C

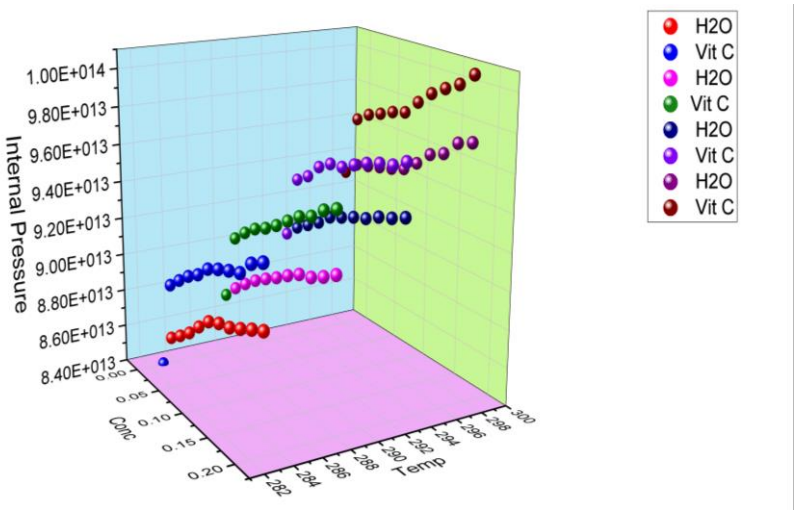


Internal pressure

Internal pressure is useful to understand the intermolecular interaction and structure of the solution. Figure 5 shows that the, internal pressure of the glucose at different temperature (283.15 K-298.15K) at different concentration (0.02 M-0.2 M) is increase with increase in temperature and molarity. This indicates that the binding

force between solute and solvent is become stronger and it shows that there is strong intermolecular interaction [15].

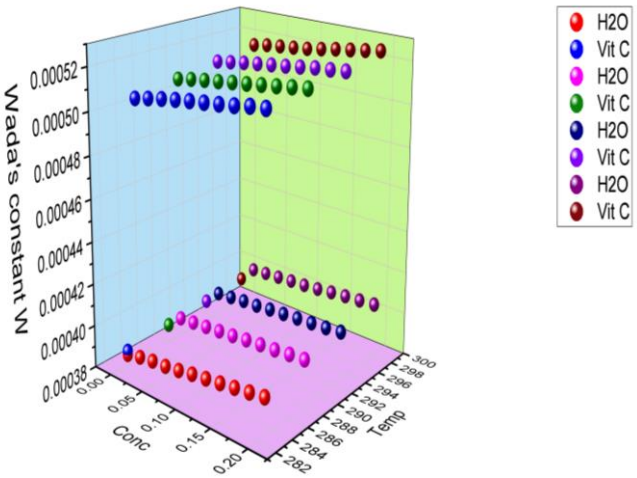
Figure 5. Internal pressure at different temperature and concentration. **Note:** ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C



Wada's constant

Wada's Constant also called as molar compressibility. Figure 6 indicate that the Wada's constant increase with arising in temperature of 283.15 K-298.15 K and also increase with respect to increase in molality of mixture. The increasing trend shows that the availability of more components and closely packing of medium and there is an increasing the interaction [16].

Figure 6. Wada's constant at different temperature and concentration. **Note:** ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C



Rao's constant

Figure 7 shows that the solution of Glucose and Vitamin C at 0.2 M of different concentration (0.02 M-0.2 M) and different temperature (283.15 K-298.15 K) is increasing with rising in temperature and concentration because the atoms are closely packed [17]. And Rao's constant also called as sound molar velocity is shown in Table 5.

Figure 7. Rao's constant at different temperature and concentration. **Note:** ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C

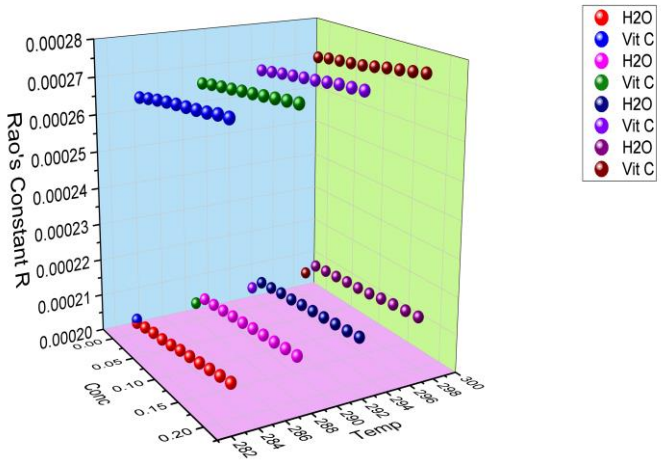


Table 5. The value of internal pressure, Wada's constant and Rao's constant at different concentration of glucose + 0.2M aq. solution of vitamin C at various temperatures (282.15 K-298.15 K).

Conc.	Internal Pressure (Nm^{-2})		Wada's Constant $(m^3mole^{-1})(ms^{-1})^{-1/7}$		Rao's Constant $(m^3mole^{-1})(ms^{-1})^{1/3}$	
	H_2O	Vitamin C	H_2O	Vitamin C	H_2O	Vitamin C
	283.15 K					
0	8.40197E+13	8.40197E+13	0.000384941	0.000384941	0.000202936	0.000202936
0.02	8.59228E+13	8.88549E+13	0.000386794	0.000507133	0.000203735	0.000266316
0.04	8.64666E+13	8.94961E+13	0.000388033	0.000508691	0.000204374	0.000267172
0.06	8.70596E+13	9.00977E+13	0.000388678	0.000510103	0.000204715	0.000267938
0.08	8.78074E+13	9.05624E+13	0.000389875	0.000511335	0.000205363	0.000268594
0.1	8.85044E+13	9.12286E+13	0.000391339	0.000512456	0.000206153	0.000269182
0.12	8.88388E+13	9.15915E+13	0.000392451	0.000513417	0.000206728	0.000269671
0.14	8.90442E+13	9.18965E+13	0.000393612	0.000514409	0.000207332	0.000270185
0.16	8.94051E+13	9.21589E+13	0.000394815	0.000515489	0.000207963	0.000270744
0.18	8.98009E+13	9.29785E+13	0.000396059	0.000516913	0.000208618	0.000271518
0.2	9.01517E+13	9.33985E+13	0.000397288	0.000517722	0.000209265	0.000271914
	288.15 K					
0	8.71922E+13	8.71922E+13	0.000388394	0.000388394	0.000204892	0.000204892
0.02	8.79663E+13	9.07684E+13	0.000394643	0.000509946	0.000208054	0.000268041

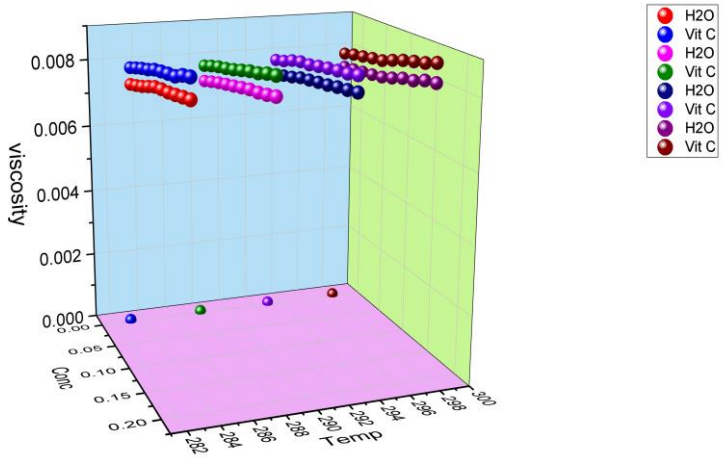
0.04	8.85918E+13	9.14192E+13	0.000395403	0.000511338	0.000208445	0.000268771
0.06	8.91637E+13	9.19679E+13	0.000396177	0.000512371	0.000208844	0.000269328
0.08	8.96422E+13	9.23492E+13	0.000396991	0.000513329	0.000209268	0.000269817
0.1	9.00821E+13	9.28272E+13	0.000397729	0.000514455	0.000209646	0.000270407
0.12	9.05734E+13	9.33868E+13	0.000398694	0.000515387	0.000210163	0.000270879
0.14	9.10153E+13	9.39346E+13	0.000399469	0.000516466	0.000210563	0.000271441
0.16	9.12392E+13	9.42777E+13	0.000400103	0.000517484	0.000210877	0.000271966
0.18	9.16496E+13	9.49007E+13	0.000401038	0.000518628	0.000211376	0.000272564
0.2	9.21219E+13	9.52819E+13	0.000401733	0.000519591	0.000211725	0.000273067
293.15 K						
0	9.00614E+13	9.00616E+13	0.000389862	0.000389862	0.000205796	0.000205796
0.02	9.07458E+13	9.34645E+13	0.000396616	0.000512603	0.000209268	0.000269671
0.04	9.12283E+13	9.39508E+13	0.000397369	0.000513714	0.000209654	0.000270253
0.06	9.17023E+13	9.47429E+13	0.000398219	0.000514845	0.000210101	0.000270846
0.08	9.23198E+13	9.51939E+13	0.000398632	0.000515805	0.000210278	0.000271335
0.1	9.26438E+13	9.53054E+13	0.000399513	0.000516767	0.000210743	0.000271826
0.12	9.29806E+13	9.57077E+13	0.000400154	0.000517611	0.000211061	0.000272244
0.14	9.32391E+13	9.60715E+13	0.000400784	0.000518677	0.000211372	0.000272797
0.16	9.36472E+13	9.63504E+13	0.000401399	0.000519741	0.000211674	0.000273351
0.18	9.39113E+13	9.65421E+13	0.000402001	0.000520346	0.000211968	0.000273622
0.2	9.42697E+13	9.69863E+13	0.000402927	0.000521152	0.000212462	0.000274017
298.15 K						
0	9.30671E+13	9.30671E+13	0.000391509	0.000391509	0.000206811	0.000206811
0.02	9.37766E+13	9.63696E+13	0.000399063	0.000515538	0.000210775	0.000271473
0.04	9.39776E+13	9.68646E+13	0.000399713	0.000516753	0.000211098	0.000272119
0.06	9.42034E+13	9.71607E+13	0.000400298	0.000517503	0.000211381	0.000272478
0.08	9.44093E+13	9.74925E+13	0.000400934	0.000518235	0.000211695	0.000272824
0.1	9.46867E+13	9.77188E+13	0.000401387	0.000519028	0.000211897	0.000273209
0.12	9.52755E+13	9.84777E+13	0.000402118	0.000520232	0.000212275	0.000273852
0.14	9.60121E+13	9.91566E+13	0.000403122	0.000521522	0.000212812	0.000274544
0.16	9.63355E+13	9.96342E+13	0.000403892	0.000522535	0.000213209	0.000275066
0.18	9.71337E+13	1.00056E+14	0.000404537	0.000523635	0.000213529	0.000275641
0.2	9.74222E+13	1.00745E+14	0.000405256	0.000524819	0.000213895	0.000276268

Viscosity

Viscosity is the important parameter which shows the strong bond between two components. The viscosity of the glucose and aqueous vitamin C solution at different temperature 283.15 K-298.15 K and concentration 0.02-0.2

molality is increasing with increase in temperature and concentration (Figure 8). This happen because strong interaction between molecules of solute and solvent because of that cohesive force is increase [18].

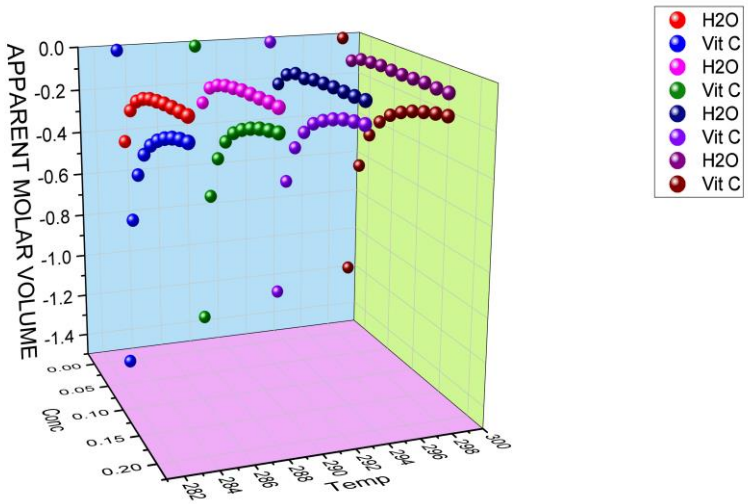
Figure 8. Viscosity at different temperature and concentration. **Note:** ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C



Apparent molal volume

Solute and solvent interaction confirm with the positive result of apparent molal volume parameter. The solution of glucose and vitamin C at different concentration (0.02 M-0.2 M) and at various temperatures (283.15 K-298.15 K) shown in Figure 9 is increase with respect to increase in temperature and concentration [19].

Figure 9. Apparent molar volume at different temperature and concentration. **Note:** ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C



Adiabatic compressibility

Compressibility is a very microscopic observable parameter. It can be used to identify the solvation property of solute in aqueous solution. Figure 10 shows that at different concentration and temperature of the solution of Glucose and aqueous vitamin C is decrease with increase in temperature and concentration. The decrease in value of compressibility and rising in value of velocity shows that the interaction between solute and solvent due to which structural arrangements of other molecules affected is shown in Table 6 [20].

Figure 10. Adiabatic compressibility at different temperature and concentration. **Note:** (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C

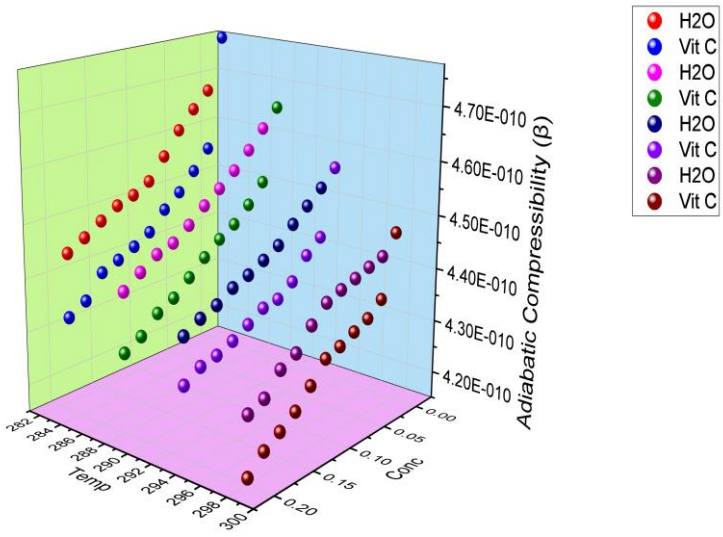


Table 6. The value of viscosity, apparent molal volume and adiabatic compressibility at different concentration in glucose +0.2 M aqu. Solution of Vitamin C at different temperatures (282.15 K-298.15 K)

Conc.	Viscosity ($Kgm^{-1}s^{-1}$)		Apparent Molal Volume ((m^3mole^{-1}))		Adiabatic Compressibility (m^2N^{-1})	
	H_2O	Vitamin C	H_2O	Vitamin C	H_2O	Vitamin C
	283.15 K					
0	5.36994E-05	5.36994E-05	0	0	4.77466E-10	4.77466E-10
0.02	0.007502068	0.00798734	-0.3986565	-1.4614297	4.67706E-10	4.56183E-10
0.04	0.007603065	0.008105055	-0.2332117	-0.7381336	4.64742E-10	4.52536E-10
0.06	0.007711511	0.008217928	-0.1707301	-0.5001643	4.61388E-10	4.49224E-10
0.08	0.007844309	0.008310315	-0.1380848	-0.3822657	4.57131E-10	4.46755E-10
0.1	0.007970228	0.008436256	-0.1170569	-0.3166321	4.53207E-10	4.43336E-10
0.12	0.008041294	0.008514448	-0.1047069	-0.2710951	4.51502E-10	4.41575E-10
0.14	0.008092007	0.008583476	-0.0935164	-0.2374922	4.50461E-10	4.40103E-10
0.16	0.008167542	0.008645525	-0.0860897	-0.2108877	4.48577E-10	4.38811E-10
0.18	0.008248925	0.008798656	-0.0800932	-0.1917422	4.46499E-10	4.34608E-10

0.2	0.008323564	0.008888873	-0.0750662	-0.1785522	4.44682E-10	4.32709E-10
288.15 K						
0	5.46355E-05	5.46355E-05	0	0	4.65696E-10	4.65696E-10
0.02	0.007451971	0.007903178	-0.2444399	-1.2859471	4.62416E-10	4.52014E-10
0.04	0.007562263	0.008019752	-0.1550446	-0.6596091	4.59062E-10	4.48528E-10
0.06	0.007665349	0.008122466	-0.1230237	-0.4562223	4.56034E-10	4.45752E-10
0.08	0.007754876	0.008200282	-0.1038189	-0.3535674	4.53517E-10	4.43908E-10
0.1	0.007839504	0.008293054	-0.0933142	-0.2905292	4.51276E-10	4.41513E-10
0.12	0.007931529	0.008399964	-0.0826336	-0.2523176	4.48644E-10	4.38835E-10
0.14	0.008017396	0.008505267	-0.0774881	-0.2230136	4.46416E-10	4.36175E-10
0.16	0.008070641	0.008578917	-0.0733765	-0.1996734	4.45414E-10	4.34563E-10
0.18	0.008151685	0.008697343	-0.0680272	-0.1827472	4.43279E-10	4.31567E-10
0.2	0.008244164	0.008778283	-0.0669871	-0.1687352	4.40999E-10	4.29829E-10
293.15 K						
0	5.51824E-05	5.51824E-05	0	0	4.56438E-10	4.56438E-10
0.02	0.007507944	0.007936543	-0.1795468	-1.2004581	4.53511E-10	4.44115E-10
0.04	0.007595373	0.008027025	-0.1166476	-0.6206556	4.51073E-10	4.41715E-10
0.06	0.007681745	0.008164023	-0.0916003	-0.4346024	4.48642E-10	4.37845E-10
0.08	0.007791738	0.008251073	-0.0944262	-0.3385545	4.45785E-10	4.35755E-10
0.1	0.007856972	0.008286927	-0.0805322	-0.2756455	4.44142E-10	4.35306E-10
0.12	0.007925494	0.008367717	-0.0759889	-0.2390673	4.42599E-10	4.33526E-10
0.14	0.007982674	0.008442257	-0.0719835	-0.2097574	4.41462E-10	4.31838E-10
0.16	0.008062686	0.008504086	-0.0706306	-0.1869503	4.39601E-10	4.30562E-10
0.18	0.008121432	0.008554304	-0.0684472	-0.1728424	4.38469E-10	4.29913E-10
0.2	0.008193336	0.008643318	-0.0637509	-0.1616964	4.36682E-10	4.27999E-10
298.15 K						
0	5.58177E-05	5.58177E-05	0	0	4.46913E-10	4.46913E-10
0.02	0.007591429	0.007994178	-0.0910811	-1.1183369	4.43557E-10	4.35491E-10
0.04	0.007637905	0.008083966	-0.0668104	-0.5751606	4.42773E-10	4.33125E-10
0.06	0.007688366	0.008146747	-0.0617539	-0.4024763	4.41771E-10	4.31929E-10
0.08	0.007735971	0.008215153	-0.0573176	-0.3171972	4.40911E-10	4.30585E-10
0.1	0.007794809	0.008268062	-0.0599274	-0.2633083	4.39825E-10	4.29706E-10
0.12	0.007897847	0.008399029	-0.0603866	-0.2278882	4.37057E-10	4.26199E-10
0.14	0.008022079	0.008518818	-0.0578638	-0.2007021	4.33458E-10	4.23068E-10
0.16	0.008087599	0.008610086	-0.0552336	-0.1813946	4.31994E-10	4.21000E-10
0.18	0.008224211	0.008693088	-0.0587872	-0.1650557	4.28406E-10	4.19157E-10
0.2	0.008285707	0.008817132	-0.0568294	-0.1531902	4.27167E-10	4.16138E-10

Acoustic impedance

Figure 11 shows that the projection of acoustic impedance in aqueous Glucose+Vitamin C solution at different temperature and concentration. The trends increase with rise in molarity and concentration because the value of density increases so that the value of impedance increases linearly [21].

Figure 11. Acoustic impedance at different temperature and concentration. **Note:** (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C; (●) H_2O; (●) Vit C

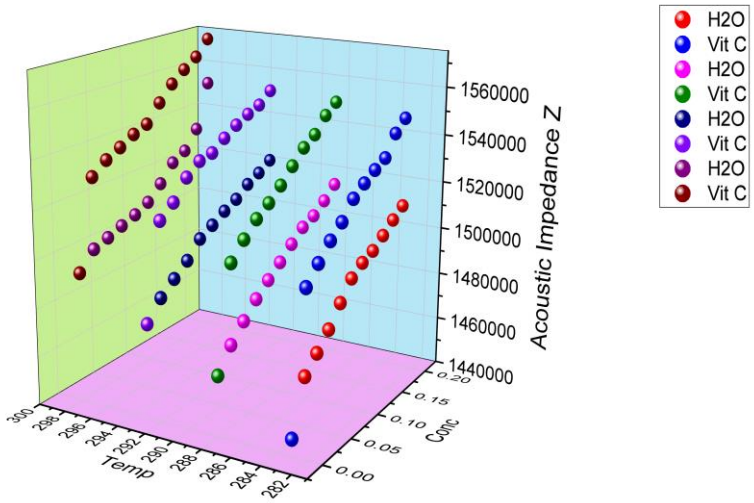


Table 7. The value of acoustic impedance, relative association and relaxation strength at different concentration in glucose +0.2 M aq. solution of vitamin C at different temperatures (282.15 K-298.15 K)

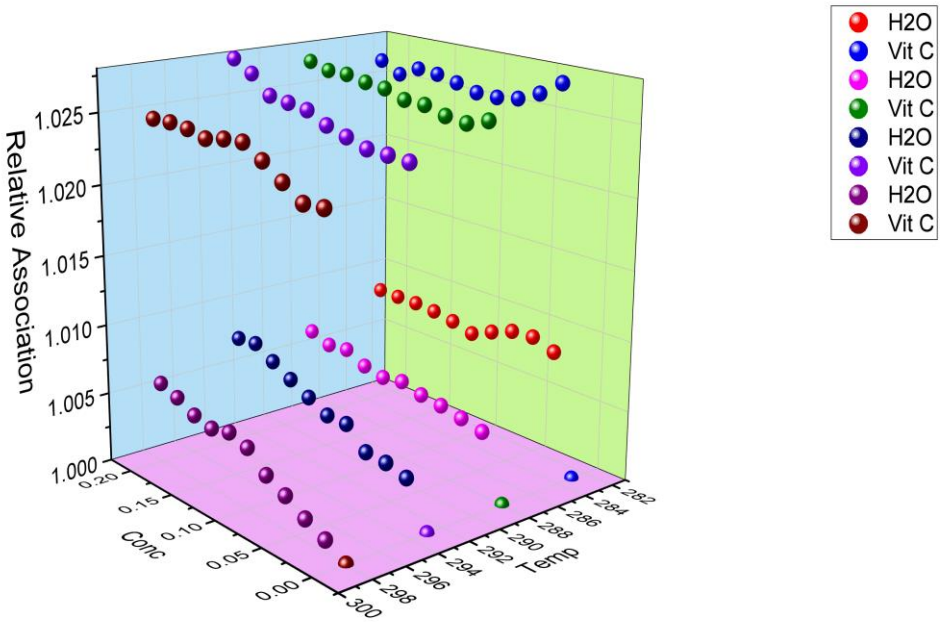
Conc.	Acoustic Impedance (Kg-m^{2}s^{-1})		Relative association		Relaxation Strength	
	H_2O	Vit C	H_2O	Vit C	H_2O	Vit C
	283.15 K					
0	1446992.77	1446992.77	1	1	0.18162307	0.18162307
0.02	1467868.25	1502469.44	1.008642058	1.027372155	0.17121735	0.16848398
0.04	1473554.32	1508743.97	1.009185253	1.026369075	0.16706997	0.16204284
0.06	1479582.37	1514676.56	1.009060236	1.025714762	0.16179795	0.15628886
0.08	1487062.19	1519307.62	1.008460784	1.025481565	0.15468065	0.15212736
0.1	1493986.40	1526009.01	1.007800139	1.025508479	0.14793254	0.14654506
0.12	1497457.87	1529737.43	1.008193649	1.025905422	0.14546153	0.14391243
0.14	1499589.37	1532863.40	1.008438557	1.026226826	0.14394829	0.14169039
0.16	1503258.01	1535513.29	1.008551339	1.026338818	0.14094907	0.13960461
0.18	1507245.47	1543538.17	1.008541601	1.025653513	0.13751631	0.13198169

0.2	1510781.95	1547884.90	1.008572373	1.026393031	0.13451865	0.12925440
288.15 K0						
0	1464716.96	1464716.96	1	1	0.16044928	0.16044928
0.02	1473509.04	1506200.90	1.004548745	1.025729789	0.15862606	0.15726452
0.04	1479859.74	1512560.57	1.004880372	1.025227749	0.15360000	0.15129843
0.06	1485648.31	1518036.58	1.005167471	1.025385456	0.14899375	0.14688222
0.08	1490462.21	1521902.56	1.005335545	1.025802773	0.14506860	0.14414373
0.1	1494934.38	1526629.10	1.005722593	1.025827143	0.14171355	0.14018425
0.12	1499757.26	1532250.11	1.005438518	1.026300909	0.13719123	0.13602975
0.14	1504205.17	1537665.91	1.005712696	1.026430038	0.13370443	0.13160898
0.16	1506577.89	1541093.79	1.006397924	1.026697844	0.13254060	0.12904443
0.18	1510589.18	1547193.61	1.006195556	1.026689159	0.12881110	0.12385719
0.2	1515375.49	1551003.30	1.006704371	1.027058694	0.12533081	0.12109375
293.15 K						
0	1478829.307	1478829.30	1	1	0.14264437	0.14264434
0.02	1486262.32	1517502.88	1.003126331	1.024027529	0.14020743	0.13997560
0.04	1491079.159	1522257.61	1.003490408	1.024106012	0.13649443	0.13602975
0.06	1495739.52	1529952.50	1.003565722	1.024137755	0.13254060	0.12951100
0.08	1502079.745	1534413.21	1.004923421	1.024560598	0.12878777	0.12624243
0.1	1505234.609	1535584.75	1.004898244	1.024977339	0.12600873	0.12577514
0.12	1508668.911	1539624.93	1.005577224	1.025662491	0.12390430	0.12320185
0.14	1511343.307	1543171.87	1.006284562	1.025833722	0.12249943	0.12039048
0.16	1515476.703	1545896.58	1.007029452	1.026003714	0.11987457	0.11827968
0.18	1518216.156	1548018.63	1.007811231	1.027229781	0.11851373	0.11804423
0.2	1521651.606	1552460.17	1.007640412	1.027987255	0.11529515	0.11522460
298.15 K						
0	1493606.69	1493606.69	1	1	0.12331773	0.12331773
0.02	1500623.56	1530227.09	1.000866615	1.022243846	0.11827954	0.11739048
0.04	1502704.99	1534904.93	1.001543724	1.022098088	0.11733975	0.11616498
0.06	1505064.08	1537927.32	1.002404672	1.023022389	0.11642091	0.11475423
0.08	1507197.59	1541295.44	1.003114149	1.023992936	0.11545975	0.11310693
0.1	1510132.91	1543627.26	1.004355756	1.024816583	0.11451901	0.11216493
0.12	1515855.83	1550774.76	1.004779234	1.024665299	0.11004360	0.10579335
0.14	1522792.14	1557104.89	1.004405258	1.024331938	0.10342773	0.09987343
0.16	1525937.25	1561669.25	1.004710886	1.024633731	0.10105898	0.09631210
0.18	1533663.23	1565653.91	1.005377151	1.024732116	0.09512343	0.09298185
0.2	1552460.17	1572090.31	1.005823501	1.024639046	0.09321993	0.08725860

Relative association

Graphical trends of Figure 12 exhibits Relative association of the solution of Glucose in aqueous Vitamin C at temperature of 283.15 K-298.15 K and concentration of 0.02 M-0.2 M is increasing with increase in molality and temperature. The increasing value shows that the both solute-solute and solute-solvent interaction happen in mixture [16].

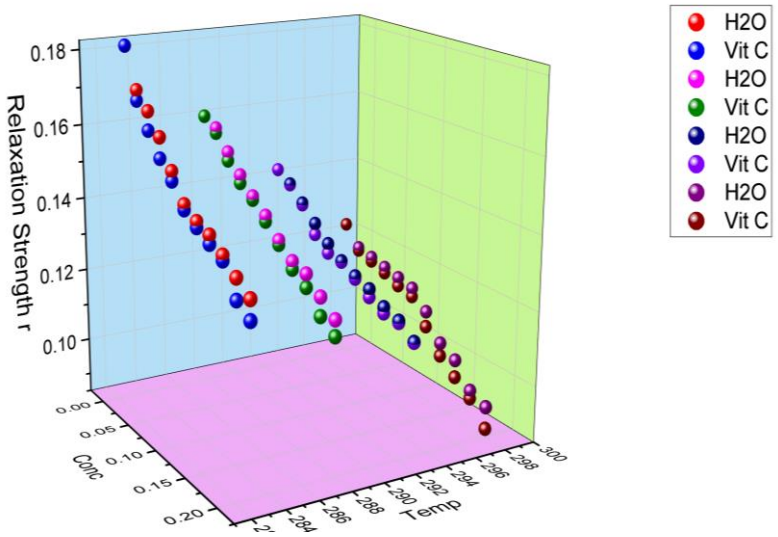
Figure 12. Relative association at different temperature and concentration. **Note:** ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C; ( ) H_2O; ( ) Vit C



Relaxation strength

According to trend, the relaxation strength in Glucose aqueous Vitamin C solution at different temperature and concentration is decreasing with increase in temperature and concentration and Figure 13 shows the result. It is directly proportional to the adiabatic compressibility. When we increase the concentration of solute in solvent then the value decreases and it shows solute-solvent interaction in the solution. It happens due to the complex solvent formation around the solute [22].

Figure 13. Relaxation strength at different temperature and concentration. **Note:** (●) H_2O; (●) Vit C; (●) H2O; (●) Vit C; (●) H2O; (●) Vit C; (●) H2O; (●) Vit C;



CONCLUSION

We find the ultrasonic velocity and density of the glucose at different concentration 0.02 M-0.2 M in the 0.2 M aqueous Vitamin C solution at different temperature ranging from 283.15 K-298.15 K. Related to velocity and density we calculate the other volumetric, acoustical and thermodynamic parameter like free length, internal pressure, Wada's constant, Rao's constant, viscosity, apparent molal volume, adiabatic compressibility, acoustic impedance, relative association. The parameters velocity, density, internal pressure, wada's constant, rao's constant, viscosity, apparent molal volume, acoustic impedance, relative association are increases with increase in concentration while Free Length, Adiabatic Compressibility, Relaxation Strength are decreases with increases in concentration. This behavior of the system concludes that there is a strong bond between them. We further conclude that, this solution control and regulate the blood sugar level in human body. And also maintain the growth of brain in human babies.

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