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Mini-Review

Intermolecular Interactions in Thermo-Acoustic Investigation of Water-Soluble Vitamin B Complexes in Various Solvent Systems: A Comparative Study

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Abstract

This study examines the intermolecular interactions between water-soluble vitamin Bs and combination compounds, focusing on volumetric, solvent, and auditory interactions. It discusses thermodynamic, chemical, and acoustic mixture interactions, revealing mixed molecular interactions. In addition, the study utilizes solvent effects to assess how varying solvent properties influence the intermolecular interactions between the vitamins and combination compounds. The findings could help create ultrasonic sound-based materials for various applications, including medical, pharmaceutical, and food industries.

Keywords: Water-Soluble Vitamin Bs, Inter-Molecular Interactions, Ultrasonic Velocity

1. Introduction

This investigation of intermolecular interactions is vital to the advancement of molecular sciences. The molecular interaction in liquid systems has been extensively studied using the ultrasonic technique. Due to its capacity to characterize the physiochemical behavior of the medium, ultrasonic method has recently become an effective tool for delivering information on the molecular behavior of liquids and solids [1]. Molecular interactions in solutions impact thermodynamics. Ultrasonic technique has poor intermolecular interactions due to its wavelength versatility. Density and sound speed are valuable tools for studying liquid mixtures since liquid structure and macroscopic properties are strongly correlated. Molecule structure and properties must be studied via non-destructive ultrasonic examination. Acoustic analysis of liquid mixtures identifies the thermodynamic characteristics of compressed liquids, which are vital in pharmaceutical, chemical, leather, cosmetic, and other industries [2].

An approximation of the nature of the molecular interactions that take place between the liquids is generated when we research the many thermodynamic features of liquid mixes and explore their acoustic and thermodynamic properties [3]. Investigating the density and the speed at which sound travels through various liquid mixtures allows us to understand their properties and molecular interactions. Ultrasonic waves help us see the forces and structures within these liquids. This technique is nondestructive and useful for exploring interactions in polymers and organic solutions. The insights gained from this research are valuable for many industries, including automotive, pharmaceuticals, textiles, and cosmetics [4,5]. Recently, acoustic parameters have gained prominence in scientific research, particularly for their role in revealing molecular interactions in liquid mixtures.

The use of ultrasonic techniques has become essential for analyzing these interactions, whether in polar or nonpolar substances. This approach has provided new perspective on the fundamental characteristics of these mixtures at the molecular scale [6]. Human pleasure depends on good health. A balanced diet supports a healthy life cycle. Vitamins are vital to the body. Vitamin H, or biotin. This water-soluble vitamin produces energy from food. Because biotin cannot be stored, it must be consumed as required. It is found in almonds, eggs, bananas, milk, cheese, mushrooms, sweet potatoes and cauliflower. It aids the metabolism of lipids, carbohydrates, and proteins [7]. Vitamins are the chemical molecules that are the essential nutrients needed for any organism's metabolism to operate properly. Niacin, commonly referred to as nicotinic acid, is a vitamin B3 that is used to treat liver issues, gastrointestinal issues, cholesterol, DNA repair, and other conditions. They are naturally present in food and necessary for the creation of diverse enzymes, energy, and red blood cells. It is a highly significant substance connected

to a number of biological processes occurring in the human body [8]. Panthenol is an alcohol, which is a pro-vitamin of B5 and is odourless, highly viscous, slightly bitter, colourless, transparent liquid at room temperature and is easily soluble in water and alcohol. Due to its biologically active nature it is also used in the biosynthesis of coenzyme A, which is responsible for enzymatic reactions leading to cell growth hence used as a moisturizer and to improve wound healing in pharmaceutical and cosmetic products [9]. Thiamine (C12H16N4OS), also known as vitamin B1, is a watersoluble substance. Thiamine has considerable metabolic importance due to its role as a cofactor in carbohydrate and energy metabolism in organisms [10].

2. A Review on Intermolecular Interation of Thermo-Acoustic Investigations of Water Soluble Vitamin BS

Chakraborty et al. had studied the study analyzes molecular interactions between glycols in biotin aqueous solutions, measuring density, speed of sound, and thermodynamic parameters. Results suggest strong interactions and hydrogen bond formation in the mixture. The hydration number for PG/HG is calculated using compressibility data [11]. Chakraborty et al in this work, Polyethylene glycol (PEG 200 and 400) were mixed with biotin-based water solutions and then examined with a DSA 5000 M at different temperatures while keeping the pressure the same. We used laboratory data to figure out acoustic and thermal factors that would help us understand how molecules interact in a mixture of vitamin B7 (Biotin), polyethylene glycols, and two other chemicals [12]. Thakur et al in this work, the effects of temperature on limiting molar expansibility and partial molar volume of niacin were investigated in binary aqueous solutions of (FeCl3 and KCl) and water. By using Masson's equation and Hepler's criterion, niacin both increases and decreases the strength of water formations [13].

Bhakri et al in this study, Vitamin B3 (niacin) aqueous solutions were subjected to sonication using DSA 5000 M at varying temperatures and a constant testing pressure. The molecular interactions in mixes of niacin and polyethylene glycols were revealed by experimental measurements of several acoustic and thermodynamic characteristics [14]. Richu et al in this studyViscometry, volume, and compressibility of L-ascorbic acid and Thiamine hydrochloride were investigated in aqueous and (0.05, 0.10, and 0.15 mol kg1) binary aqueous 1-ethyl-3-methylimidazolium hydrogen sulphate media. Tests were conducted on the sound speed, viscosity, density, and thermodynamic properties at six different temperatures and constant pressure. System molecular interactions were studied using the Cosphere overlap model. The structure-breaking potential of both vitamins was graded with positive and negative scores [15]. Chakraborty et al in this study investigates the interaction of EG, DEG, and TEG with biologically active D-Panthenol using acoustic and volumetric methods. It measures the speed of sound and densities of these compounds in aqueous solutions, determines their apparent molar volume, partial molar isentropic compression, and pair and triplet interaction coefficient [3]. Nabaparna et al has measured the density and velocity of aqueous D-Panthenol and glycols at various temperatures and concentrations using the Anton- Paar DSA 5000 M. The data was used to calculate acoustic and thermodynamic properties, including intermolecular free length, acoustic impedance, adiabatic compressibility, Wada's constant, Rao's constant, and Vander Waal's constant, providing insight into the intermolecular reactions [16].

The study determines apparent molar volumes, isentropic compressibilities, and viscosity B-coefficients for L-ascorbic acid, nicotinic acid, thiamine hydrochloride, and pyridoxine hydrochloride in water at different temperatures. It also calculates partial molar volumes, isentropic compressibilities, and viscosity B-coefficients. The study uses the transition state theory to calculate activation free energy for viscous flow [17].

3. Conclusion

Nowadays, the molecular interaction of various solvent system with various water-soluble vitamins is very important to know how their physic-chemical properties play and important role in various fields. Researchers have studied water-soluble vitamin Bs like Biotin, Niacin, D-Panthenol, and Thiamine in various solvents and temperatures. Ultrasonic investigations reveal their acoustic and volumetric properties, which can improve sector stability, safety, and efficiency. Ultrasonic investigations reveal the acoustic and volumetric properties of water-soluble vitamins and solvent combination compounds, which can improve sector stability, safety, and efficiency. Molecular interactions are crucial in biology, chemistry, and physics. The study found that various solvents interact with water-soluble vitamin Bs, revealing their behavior, material properties, and applications. More research is needed to understand vitamin solvation and intermolecular interactions with solvents, as well as their impacts on density and sound speed in diverse solutions.

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