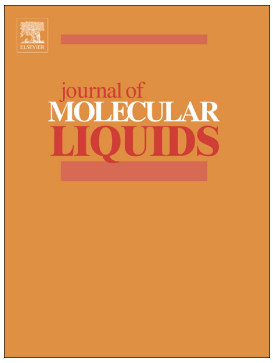

Molecular interaction studies of l-alanine and l-phenylalanine in water and in aqueous citric acid at different temperatures using volumetric, viscosity and ultrasonic methods

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Molecular interaction studies of L-alanine and L-phenylalanine in water and in aqueous citric acid at different temperatures using volumetric, viscosity and ultrasonic methods

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ABSTRACT
Densities, ultrasonic speeds and viscosities of L-alanine and L-phenylalanine in water and in 0.1 mol·kg^{-1} aqueous citric acid solutions were measured over the temperature range (298.15 to 313.15) K with interval of 5 K at atmospheric pressure. From these experimental data apparent molar volume, limiting apparent molar volume and the slope, partial molar expansibilities, adiabatic compressibility, transfer volume, Falkenhagen coefficient, Jone- Dole's coefficient, the temperature derivative of Jone-Dole's *c*oefficient, intermolecular free length, specific acoustic impedance, and molar compressibility were calculated. The results are interpreted in terms of solute – solute and solute-solvent interactions in these systems. It has also been observed that L-alanine acts as a structure breaker whereas L-phenylalanine acts as a structure maker in aqueous citric acid.

Keywords: Apparent molar volume; partial molar volume expansibility; adiabatic compressibility; molecular interactions.

1. Introduction

3-carboxy-3-hydroxypentane-1,5-dioic acid commonly known as citric acid (monohydrate) is a weak organic tri-basic acid which is found in citrus fruits such lemons, oranges, limes and some vegetables also. Citric acid and various citrates are produced in large quantities and used as a food and beverage additives and preservatives, ingredients in the production of antiviral tissues, soaps, laundry detergents, dyes and many other products in cosmetic, pharmaceutical and chemical industries [1]. Aqueous solutions with citrate ions are of significant importance considering that citric acid is one of series of acids involved in the Krebs cycle (generation of energy in living organisms through the oxidization of fats, proteins and carbohydrates) [2-5]. In view of the biological and industrial significance, various physicochemical properties of aqueous solutions of citric acid or its neutral or acidic salts were many times investigated in the literature [6-11]and only few, the most important studies are mentioned here [12–15].

Various biological processes involve volume changes and hydration of molecules and their complete understanding needs a proper idea of state and the behavior of molecules in the medium. To study the mechanism of the molecular interactions, amino acids, which are the basic building blocks of proteins and the most important model compound of proteins, are quite appropriate and useful to explore these molecular interactions. The thermodynamic and transport properties of amino acids in a variety of media can provide valuable information for the stability and denaturation of proteins which helps in promoting the progresses of human science and medicine [16-17]. Since living organism is a complex system, it is of immense importance to study the physiochemical properties of amino acids with functionally important bio-molecules in aqueous solutions [18-19]. Water which is the major component of any bio system is taken for the preparation of mixed solvent because its presence leads to hydrophobic forces [20], which are of prime importance in stabilizing the native globular structure of proteins [21].

L-alanine is a non-essential aliphatic amino acid which contains a methyl group. It has close links to metabolic pathways such as glycolysis, glycogenesis and citric acid cycle. Alteration in alanine-cycle that increases the levels of serum alanine-amino-transferase(ALT) is linked to the development of type-II diabetes. L-phenylalanine is an essential amino acid which is non-polar consisting of a phenyl ring. It is used in the manufacture of food and drink products and sold as a nutritional supplement for its reputed analgesic and anti depressant effects. So it becomes very important to study the various interactions between these amino acids and aqueous citric acid and to describe the various solute-solute and solute-solvent interactions which may be very useful in food, cosmetic, chemical and