Journal of Molecular Graphics and Modelling 44 (2013) 120–128

Contents lists available at ScienceDirect

Journal of Molecular Graphics and Modelling

journal homepage: www.elsevier.com/locate/JMGM

Investigation of simple and water assisted tautomerism in a derivative of 1,3,4-oxadiazole: A DFT study

Behzad Chahkandi[a,*], Sayyed Faramarz Tayyari[a], Maliheh Bakhshaei[a], Mohammad Chahkandi[b]

[a] Department of Chemistry, Shahrood Branch, Islamic Azad University, Shahrood, Iran
[b] Department of Chemistry, Hakim Sabzevari University, Sabzevar 96179-76487, Iran

ARTICLE INFO

Article history:
Accepted 5 April 2013
Available online 14 May 2013

Keywords:
Oxadiazole
Tautomerism
Proton transfer
Solvent effect
DFT calculations
Water assisted

ABSTRACT

Investigation of tautomerism and transition states in a derivative of 1,3,4-oxadiazole (A, B, C and D) in the gas phase and in solution and in a micro hydrated environment with 1–3 water molecules was performed by calculations at the DFT-B3LYP/6-311++G(*d*,*p*) level of theory. The solvent effect is taken into account via the self-consistent reaction field (SCRF) method. The geometries of four possible tautomers of 5-amino-1,3,4-oxadiazole-2(3H)-one were optimized in the gas phase and solution with polarized continuum model (PCM). It was found that in the gas phase and different solvents, A and C tautomers are the most stable and unstable forms, respectively.

The results show that the tautomeric interconversion C to D has the lowest Gibbs free energy changes and so the highest equilibrium constant in the gas phase and solution. The equilibrium and rate constants of intermolecular tautomerism in the absence and presence of 1–3 molecules of water were also calculated. The calculated results show that the presence of water molecules considerably reduces the barrier energy of the various reactions. Therefore, this water-assisted tautomerism can be performed fast, especially, with the assistance of two molecules of water.

1. Introduction

Oxadiazoles are important type of compounds due to their significant role in biological activities. Many oxadiazole derivatives have been prepared and some of these compounds have shown a wide spectrum of antimicrobial activity [1–7]. Some oxadiazoles with different substituents at different location on the heterocyclic ring are used as fungicidal [8,9] and antibacterial [10–13] agents with various powers. Since their discovery during the 20th century, antimicrobial agents (antibiotics and related antimicrobial drugs) have significantly reduced the threat posed by infectious diseases. For example, 2-amino-1,3,4-oxadiazole acts as muscle relaxants [14] and shows antimitotic activity [15]. Analgesic, anti-inflammatory, anticonvulsive, diuretic, and antiemetic properties are exhibited by 5-aryl-2-hydroxymethyl-1,3,4-oxadiazole derivatives [16], and 2-hydroxyphenyl1,3,4-oxadiazole acts as a hypnotic and as a sedative [17]. 1,3,4-Oxadiazole derivatives have some applications in the fields of photosensitizers [18] and liquid crystals [19].

Prototropic tautomerism is the existence of two isomers that are related to one another by the relocation of hydrogen accompanied by a switch of a single bond and adjacent double bond [20,21]. Tautomerism has been found to be important in the chemistry of oxadiazole family in general. Because of their importance, oxadiazoles have been the subject of some computational investigations focused mainly on their structural, electronic states, spectral, and optical properties [22–28]. Since tautomerism in the oxadiazole structures affect their chemical and biological activities, it is very important to know the complete scheme of tautomerism and the reaction pathways between different tautomers. Indeed, because of the acceptable accuracy of B3LYP/6-311++G(*d*,*p*) its employing for investigation of energy barriers and relative energies of proton transfer reaction has become more and more popular in computations on tautomers and isomers containing systems [29–34]. However, for estimation of our calculation accuracy the comparable experimental results could not be found. The aim of this study is to investigate the tautomerism of one of the new derivatives of 1,3,4-oxadiazole. Despite the importance of tautomerism in oxadiazoles, any reports about the study of tautomerism in 5-amino-1,3,4-oxadiazole-2(3H)-one (AOO) have not been observed in the literatures. In the present work, a complete tautomeric scheme and the reaction paths between four tautomers of AOO (Fig. 1) were studied at the B3LYP/6-311++G(*d*,*p*) level of theory. In addition, from the calculations, the geometrical parameters, relative energies of all possible tautomers, and kinetic and thermodynamic properties of tautomerism equilibrium in AOO

* Corresponding author. Tel.: +98 2733394279; fax: +98 2733394279.
E-mail address: bchahkandi@gmail.com (B. Chahkandi).

1093-3263/$ – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jmgm.2013.04.002