Theoretical Investigations of the Effect of Solvent in the IR Absorption via Density Functional Theory Calculations for a Series of Systems Theobromine-Water.

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INTRODUCTION

Molecular systems where there are hydrogen bonds are studied a long time due to its importance in the fields of physical-chemistry, biochemistry, materials science and other areas. These hydrogen bonds are responsible also for the molecular and macroscopic properties of materials. The analysis of hydrogen bonds that occur between water molecules and potential drug candidates is very important for medicine and pharmaceutical industry. Theobromine is one of the main active components of the seeds cocoa and chocolate, where is found in abundance, and is one of the main metabolites of caffeine.[1] Thereby it is very consumed by the world's population. This molecule has several medicinal properties, such as potential diuretic, antitussive, anti-inflammatory, antitumor, and is a stimulant of the peripheral physiology[2,3]. The design of effective drugs implies the knowledge of some key properties, such as the molecular behavior in aqueous solutions and the main molecular sites of electrophilic attack, nucleophilic reactions. In this study, we analyzed the changes in infrared (IR) absorption frequencies, map electrostatic potential (MEP) and frontier orbitals for theobromine isolated and in aqueous solution, using DFT calculations. We analyzed 9 different systems: theobromine isolated, theobromine interacting with water molecules ranging from one to seven (solvent explicit), and other system considering only water dielectric constant (solvent implicit) in solvation. We want to observe the changes generated by the use of explicit and implicit solvent in the properties analyzed.

METHODS

We perform the computations using Gaussian package at B3LYP/6-31g(d,p) and M06L/6-31g(d,p) level.

RESULTS AND DISCUSSION

Our results indicate that for the observed frontier orbitals the main sites of electrophilic and nucleophilic attack vary with the inclusion of new water molecules, generating different energy gaps and modifying the calculation levels significantly alter these values. The vibrational frequencies were changed mainly in the region of 3000 cm^{-1}, as expected for water molecules.

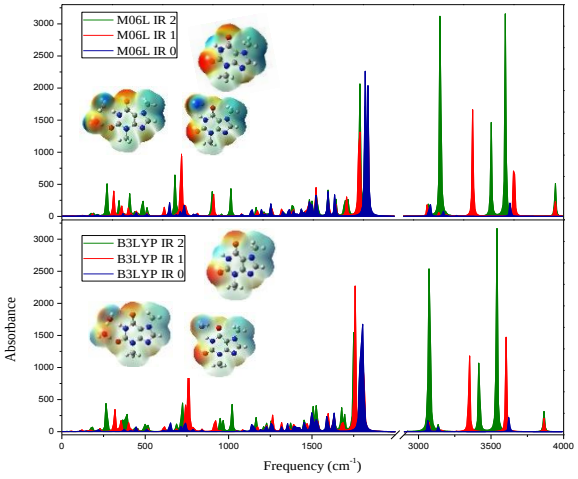

Figure 1. Infrared absorption frequencies for theobromine isolated and theobromine with one and two water molecules for M06L and B3LYP levels.

CONCLUSIONS

The present study shows that the inclusion of water molecules modifies the frontier orbitals. In the IR spectrum, the water molecules modify the absorption peaks.

ACKNOWLEDGMENTS

CAPES

[1] S. Gunasekaran et al. *Spectrochim. Acta Part A* 61 117–127 (2005).
[2] N. Sugimoto et al. *Nutrition and Cancer*. 66(3), 419–423 (2014).
[3] Usmani et al. *The FASEB Journal*. 19 (2005).