Study of Paracetamol Oxalic Acid Cocrystal Using Vibrational Spectroscopy and Quantum Chemical Approach

K. Srivastava 1, M. R. Shimpi 2, A. Srivastava 1, P. Tandon 1, S. P. Velaga 2

1 University of Lucknow, 2 Lulea University of Technology

Purpose
Study of conformational stability, structural, electronic and charge transfer properties of paracetamol-oxalic acid cocrystal

Methods
Paracetamol-oxalic acid cocrystal was prepared from solution crystallization methods. Cocrystal was characterized for purity by differential scanning calorimetry (DSC) and X-ray powder diffraction (XRPD). Fourier transform infrared (FT-IR) and Raman spectroscopy were used to collect vibrational modes of materials. The Density functional theory was adopted by employing B3LYP/6-311++G(d,p) basis set level to calculate the properties of the title molecule. Calculation of structural parameters, vibrational wavenumber, FT-IR and FT-Raman intensities of the title compounds have been carried out using Gaussian 09 program. The vibrational assignments of the normal modes were performed on the basis of the PED calculations by using the GAR2PED program. Raman and infrared spectra were simulated using a pure Lorentzian band profile (fwhm = 8 cm⁻¹) using indigenously developed software.

Results
The study has been focused on the most stable conformer which is selected after the full geometry optimization of the molecule and gives good structural agreement with crystallographic data. A detailed assignment of the FT-IR and FT-Raman spectra has been done along with potential energy distribution for each vibrational mode for isolated molecule as well as hydrogen bonded network considering intermolecular interactions. The observed and scaled wavenumber of most of the bands has been found to be in better agreement for hydrogen bonded network. Molecular electrostatic potential surface was plotted for predicting the charge density distribution and structure activity relationship.

Conclusion
The calculated results are used to simulate infrared and Raman spectra which showed good agreement with observed spectra. The noted discrepancies between experimental and theoretical results in gas phase are due to the fact that the calculations were done on the single molecule in gaseous state neglecting the intermolecular interactions. A better agreement is obtained when intermolecular interactions are incorporated.