Aromatic-carbohydrate interactions: an NMR and computational study of model systems

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Understanding molecular recognition processes is of paramount importance for the life sciences and for the elucidation, at the molecular level, of the events at the heart of biological phenomena. Many of them are mediated by interactions between proteins and the carbohydrates present on the surface of the cells.[1] Hydrogen bonding and non-polar interactions play an important role in the binding process and also, the presence of aromatic rings in the binding sites of lectins has been highlighted as essential for recognizing neutral sugars (especially of the Gal/GalNAc and Glc/GlcNAc families).[2] The importance of these aromatic amino acids has been confirmed by site-directed mutagenesis.[3] For the molecular recognition process, both the structure and conformation of the carbohydrate[4] as well as the nature and orientation of the aromatic rings are of importance.[5] This so-called "stacking interaction" between the carbohydrate and aromatic amino acid side chains is also referred to as a “CH/π interaction”.[2,6]

The interaction of simple carbohydrates with aromatic moieties has been investigated experimentally using NMR spectroscopy. The analysis of the induced changes in the chemical shifts of the sugar proton signals upon addition of aromatic entities has been interpreted in terms of interaction geometries. Phenol as well as aromatic aminoacids (Phe, Tyr, Trp) have been used. The observed sugar-aromatic interaction depends on the chemical nature of the sugar, thus on the stereochemistry of the different carbon atoms, and on the solvent. A preliminary study of the solvation state of a model monosaccharide (methyl β-galactopyranoside) in aqueous solution, both alone and in the presence of benzene and phenol has also been carried out by monitoring intermolecular homonuclear solvent-sugar and aromatic-sugar NOEs.

These experimental results have been compared with those obtained by density functional theory methods and molecular mechanics calculations.

Referencias

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