T2: O–12

Comparative study of binding interactions between porphyrin systems and aromatic compounds of biological importance by multiple spectroscopic techniques

Magdalena Makarska-Białokoz[1]

[1] *Faculty of Chemistry, Maria Curie-Sklodowska University, M. Curie-Sklodowska Sq. 2, 20-031 Lublin, Poland, e-mail: makarska@hektor.umcs.lublin.pl*

The specific spectroscopic and redox properties of porphyrin systems, especially their high ability to emit fluorescence, predestine this class of compounds to fulfill the role of sensors during interacting with different biologically active substances. Monitoring of binding interactions in the systems porphyrin-biologically active compound is a key question not only in the field of physiological functions of life organisms, but also in environmental protection, notably in the light of the rapidly growing drug consumption and concurrently the production of drug effluents.

Not always beneficial action of the compounds mentioned above on natural porphyrin systems (e.g. chlorophyll), induces to further studies, with commercially available porphyrins as the model systems. Therefore the binding process between several water-soluble porphyrins (4,4',4'',4'''-(21*H*,23*H*-porphine-5,10,15,20-tetrayl)tetrakis-(benzoic acid), 5,10,15,20-tetrakis (4-sulfonatophenyl)-21*H*,23*H*-porphine, 5,10,15,20-tetrakis[4-(trimethylammonio)phenyl]-21*H*, 23*H*-porphine tetra-*p*-tosylate, 5,10,15,20-tetrakis(1-methyl-4-pyridyl)-21*H*,23*H*-porphine tetra-*p*-tosylate, the Cu(II) complexes of H_2TTMePP and H_2TMePyP), as well as chlorophyll a, and a series of biologically active compounds, such as caffeine [1], guanine [2,3], theophylline, theobromine, xanthine [4], uric acid and its sodium salt [5], has been studied in different aqueous solutions analysing their absorption and steady-state fluorescence spectra. The fluorescence lifetimes and the quantum yields of the porphyrins examined were also established. The comparison of the binding (K_a) and fluorescence quenching (K_{SV}) constants for all the systems studied was presented. The magnitude of K_a and K_{SV} values for particular quenchers decreases in a series: uric acid>guanine>caffeine> theophylline>theobromine>xanthine. Within methylxanthines the manner and magnitude of quenching depend on the number and position of $–CH_3$ groups of particular xanthine compounds.

The porphyrin fluorescence quenching can be explain by the process of the photoinduced intermolecular electron transfer from aromatic compound to the center of the porphyrin molecule, playing the role of the binding site. Calculated parameters suggest that in all the systems studied there are obviously characters of static quenching, as a consequence of the π-π-stacked non-covalent and non-fluorescent complexes formation between porphyrins and interacting compounds, accompanied simultaneously by the additional specific binding interactions, proceeding in all probability in the aftermath of the existence of different forms of the fluorophore (porphyrin), which do not have an identical accessibility to the quencher. The formation of different porphyrin forms depends on the conditions of the microenvironment in the particular systems.

Presented results can be valuable for designing of new fluorescent porphyrin chemosensors or monitoring of drug traces in aqueous solutions. The obtained outcomes have as well the toxicological and medical importance, providing insight into the interactions of the water-soluble porphyrin with biologically active substances.

Keywords: Porphyrins; Methylxanthines; Guanine; Uric acid

Acknowledgment

The research was carried out with the equipment purchased thanks to the financial support of the European Regional Development Fund in the framework of the Operational Program Development of Eastern Poland 2007-2013 (Contract No. POPW 01.03.00-06-017/09).

References

[1] M. Makarska-Białokoz, J. Fluoresc. 22 (2012) 1521.
[2] M. Makarska-Białokoz, Cent. Eur. J. Chem. 11 (2013) 1360.
[3] M. Makarska-Białokoz, J. Lumin. 147 (2014) 27.
[4] M. Makarska-Białokoz, J. Mol. Struct. 1081 (2015) 224.
[5] M. Makarska-Białokoz, P. Borowski, J. Lumin. 160 (2015) 110.