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Multifunctional biomass-derived and N-doped carbon quantum dots – the versatile nanoparticles for ion sensing with potential biological and pharmacological activity

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The aim of this study was to prepare, characterize and investigate the potential application of carbon quantum dots (CQD) derived from *Citrus clementina* peel. The prepared nanoparticles by hydrothermal synthesis using citric acid and amino acids of different complexity (Ala, Arg, Asn, Gln, Glu, Gly, His, Leu, Lys, Phe, Ser i Trp) represented model systems. The samples obtained from citric acid and amino acids Ala, Arg, His, Leu, Lys, and Trp showed great properties with calculated quantum yield (QY) from QY= 12.97% - 36.43% under investigated pH=7. Hence, these amino acids were selected for the biomass-derived CQD preparation from *Citrus clementina* peel. The results indicated the versatility among the prepared samples regarding optical, physical and chemical properties of nanoparticles, as well as on the biological activities, compared to the model systems. Furthermore, the best-performing samples from each series of synthesis were extensively studied regarding chemical (solubility, EDS), physical (AFM, FTIR, PXRD), optical (spectrofluorimetry, UV-Vis spectroscopy), biological and pharmacological properties. The biological activities of prepared samples were investigated by spectrophotometric methods of antiradical activity (DPPH method), inhibition of protein denaturation (bovine serum albumin and egg albumin), and biocompatibility/cytotoxicity was investigated on tumor cell lines (HeLa, NCI-H385, CaCo-2, D54). The samples were also utilized as fluorescent nanoprobe for selective and sensitive detection of Fe^{3+} ions and developed models were tested for the Fe^{3+} ion detection in real well-water samples. This research could be a good example of sustainable biomass waste utilization with potential for biomedical analysis and ion sensing applications.

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