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Removal of copper (II), chloride and methylene blue using eggshell residues as low-cost biosorbents

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Biosorption, involving the removal of contaminants such as metal ions and dyes by materials of biological origin, can be considered an attractive alternative to traditional technologies. Concerning the process Life Cycle Analysis and economical feasibility, these applications can be particularly interesting when biowastes are used as effective biosorbents.This work aims to study the use of eggshell residues as low-cost biosorbents for copper (II), chloride and methylene blue biosorption. In that regard, eggshell powder (EP) and calcined eggshell powder (CEP) were prepared. Biosorbents physicochemical properties were characterized by Fourier-transform infrared (FTIR) and X-ray fluorescence (XRF) analyses, as well as specific surface area, porosity and density determination. Batch assays were performed in order to assess biosorption optimal conditions concerning medium pH, contact time and biosorbent concentration.FTIR spectra and X-ray fluorescence analysis show that calcium oxide is the main chemical component of EP. Calcination at 1000 ºC for 2 h induces changes in eggshell powder composition, with calcium hydroxide and carbonate being identified as CEP main constituents. Further modifications resulting from biosorbent calcination pretreatment concerns the increasing of its specific surface area and porosity. From biosorption assays it is possible to conclude that copper (II) and chloride uptake by EP and CEP is optimal in acid solutions, respectively at pH 6 and 3, while methylene blue is more efficiently removed in alkaline conditions, at pH 8. For the biosorption systems in study, equilibrium was reached rapidly, nearly after 2 h of incubation, a good indicator for their use in large-scale applications. Regarding the optimal biosorbent dosage determined and the overall uptake results, it can be assumed that CEP has greater potential to be used as biosorbent than EP.