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Flower-like structures of carbonaceous nanomaterials obtained from biomass for the treatment of copper ion-containing water and their re-use in organic transformations

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Abstract:
In the present work, raw waste material obtained from polluting dried tree fibres (raw TF) as a source of natural carbon was used for the removal of contaminating copper ions in water. Through two sequential steps of oxidation, carbonaceous adsorbent materials were obtained. Namely, tree fibre activated carbon treated with sulphuric acid (TFSA) and oxidised activated carbon modified using Hummer's method (TFHM). These materials were then characterized using techniques such as SEM, TEM, XRD, FTIR, XPS, TGA, Raman, and BET. The surface areas were found to have an increase from 0, 0.3109 and 55.0107 m2/g for raw TF, TFSA, and TFHM, respectively. The carbonaceous adsorbents were then used in batch adsorption studies for the removal of copper ions in a test water solution. The maximum adsorption capacities determined by non-linear estimation models at the optimum pH 6, were 11.04 and 80.19 mg/g for TFSA and TFHM, respectively. Furthermore, copper is known to facilitate many organic transformations such as reduction and cyclisation, thus, the spent carbonaceous adsorbents were re-used in cyclocondensation and catalytic reduction reactions to avoid discarding these into the environment and creating secondary pollutants. The initial catalytic studies of cyclocondensation of benzamine lead to 96% and 98% yield of desired product via recrystallization while catalytic reduction of 4-nitrophenol was obtained 92% within 22 min.