Metal free and sunlight driven g-C_3N_4 based photocatalyst using carbon quantum dots from Arabian dates: Green strategy for photodegradation of 2,4-dichlorophenol and selective detection of Fe^{3+}

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ABSTRACT

The fabrication of photocatalyst with a visible response and prolonged lifetime of charge carriers is a significant tactic to treat EDCs. In this work, a green synthesis route was adopted to prepare carbon quantum dots (CQDs) from Arabian dates (AD-CQDs) *via* hydrothermal method. The different weight percentages of fabricated AD-CQDs (10, 15 and 20 wt%) were coupled with graphitic carbon nitride (g-C_3N_4) to construct AD-CQDs/g-C_3N_4 composites to degrade 2,4-dicholorophenol (2,4-DCP) under sunlight irradiation with an average light intensity of ~973 × 100 lx. The obtained AD-CQDs were used as a highly selective sensor for ferric (Fe^{3+}) ions, with a low detection limit of 1 nM. The increase loading of AD-CQDs resulted in particle agglomeration which decreased the specific surface area of g-C_3N_4 from 74.799 m^2/g to 62.542 m^2/g. The low specific surface area in the composites did not hamper the photocatalytic performance in which all composites showed a higher degradation rate than that of g-C_3N_4. With the optimum loading of AD-CQDs (20 wt%), the composite degraded 100% of 2,4-DCP in 90 min which was 1.7 times higher than g-C_3N_4 (59.48%). The excellent photocatalytic performance was mainly correlated to the effective separation of photogenerated electrons as evidenced by TRPL and transient photocurrent response. The second factor is visible light response because of the minor decrease of band gap energy as evidenced in UV–vis DRS spectra. Both factors are attributed to the dual functions of AD-CQDs as electron acceptors and photosensitizers. The simple and low-cost synthesis strategy could be an alternative to obtain sunlight driven photocatalysts without coupling with metal dopants or other semiconductors.

KEYWORDS

Arabian dates; CQDs/g-C_3N_4 composite; 2,4-DCP; Fe^{3+} metal sensing; Photocatalytic degradation

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