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Sustainable Strategy for Upcycling Organic Waste into Highly Luminescent Carbon Dots

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INTRODUCTION & AIM

Carbon Dots (CDs) are fluorescent carbon-based nanoparticles with remarkable properties. The fabrication of CDs from different types of waste and renewable carbon sources (biomass, residues, and others) have been shown to present relatively low QY_{FL} values (below 20%). This is problematic because typical applications in which CDs are used require as high of a QY_{FL} value as possible.

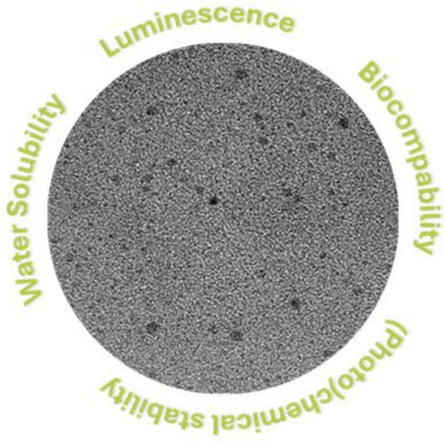

Figure 1. Carbon Dots properties.

Thus, there is a need to develop novel and cleaner strategies for producing CDs that do not sacrifice their performance, through the reduction of the amount of commercial chemicals by incorporating organic waste (maintaining appreciable QY_{FL} values, irrespective of the selected waste material).

AIM: Optimize a bottom-up route in which different CDs can be produced from diverse types of waste material while consistently obtaining higher QY_{FL} values. More specifically, it will establish a framework to produce different waste-based CDs with strong enough fluorescence for future application-oriented research while allowing for waste upcycling in a circular economy approach.

METHODOLOGY

Carbon Dots production via Bottom-up approach

RESULTS & DISCUSSION

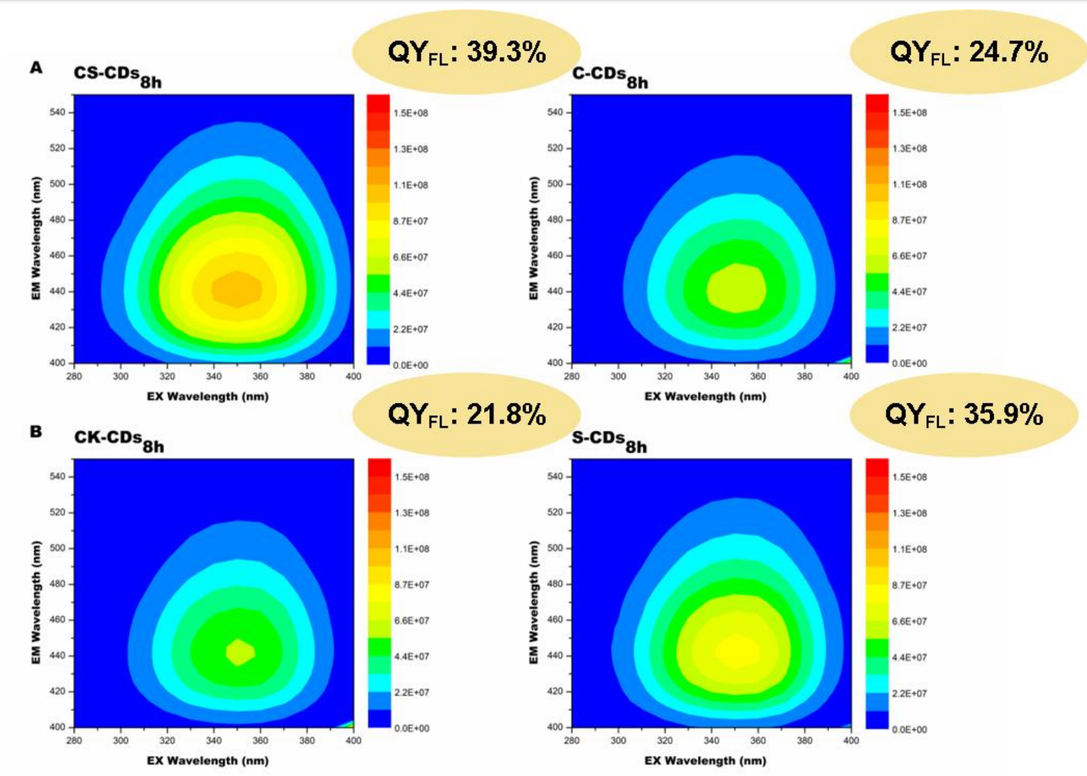

Figure 2. EECPs of corn stover CDs ($CS\text{-}CDs_{8h}$), coffee CDs ($C\text{-}CDs_{8h}$), cork CDs ($CK\text{-}CDs_{8h}$) and sawdust CDs ($S\text{-}CDs_{8h}$).

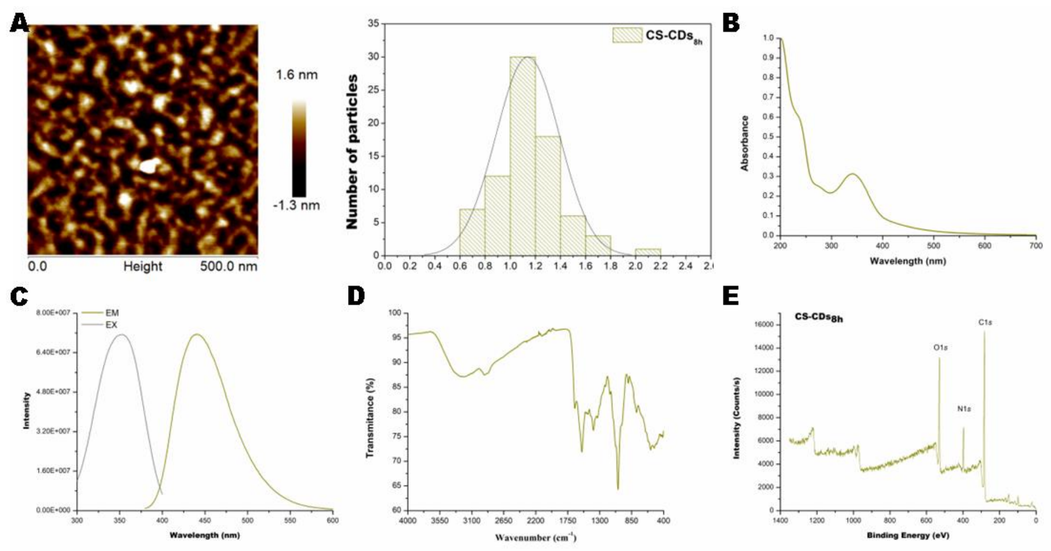

Figure 3. $CS\text{-}CDs_{8h}$ characterization. AFM **(A)**. Absorption spectra **(B)**. Emission and excitation spectra **(C)**. FT-IR spectra **(D)**. XPS Survey **(E)**.

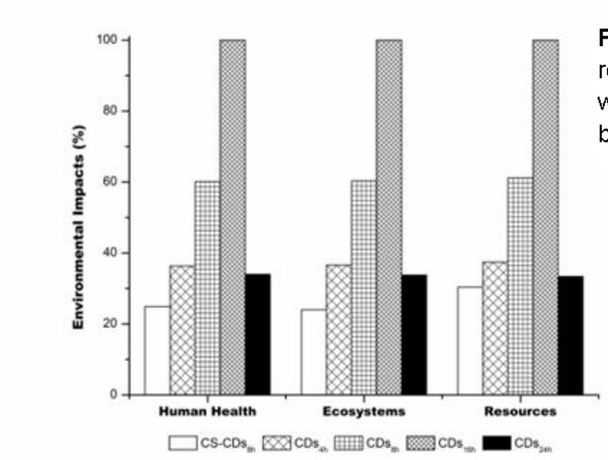

Figure 4. Comparison of relative environmental impacts of $CS\text{-}CDs_{8h}$ with CDs without corn stover (CDs_{xh}) using a QY_{FL}-based FU.

CONCLUSION

CDs were produced from different waste carbon sources, such as corn stover, spent coffee grounds, cork powder, and sawdust, with appreciable QY_{FL} values being consistently obtained (up to ~40%).

An LCA study demonstrated that the production of CDs from waste material, with our approach, is associated with lower environmental impacts than the production of corresponding CA:EDA-only CDs.

Thus, this study provides an efficient, environmentally responsible framework for upcycling a wide range of organic wastes into high-performance carbon dots without sacrificing fluorescence efficiency.

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