Synthesis of Urea-doped carbon quantum dots from Guava (*Psidium guajava*) leaf extract via microwave-assisted approach

Restituto M. Cortez Jr.[a,b] *, Aldrin A. Tan [c,d,e], Jose Emmanuel L. Camachod [e], Rhea G. Abisado-Duque[a], Marlon T. Conato [d,e]

[a] Department of Biology, School of Science and Engineering, Ateneo de Manila University, Quezon City, Philippines

[b] Senior High School Department, Batasan Hills National High School, Quezon City, Philippines

[c] Mathematics and Physics Department, College of Science, Adamson University, Manila City, Philippines

[d] Materials Science and Engineering Program, College of Science, University of the Philippines, Diliman, Quezon City, Philippines

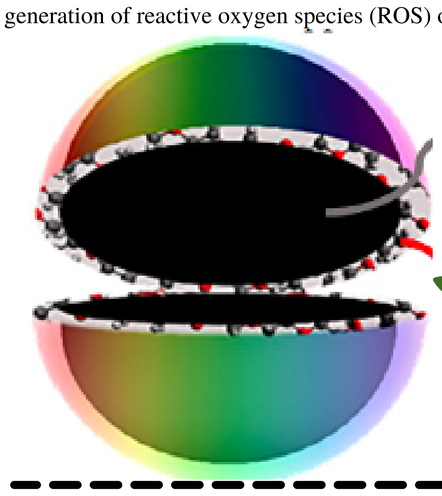
[e] Polymer Laboratory, Institute of Chemistry, University of the Philippines, Diliman, Quezon City, Philippines

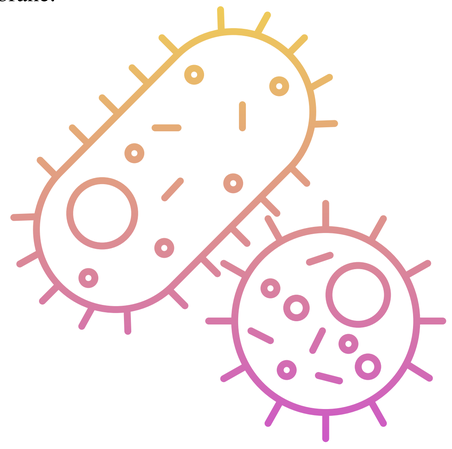
ABSTRACT

Carbon quantum dots (CQDs) have shown promising and consistent antibacterial activity, both in vitro and in vivo studies. In addition, bacterial membrane's affinity to these synthesized CQDs can be increased through surface modification. Doping to increase positive charges on the material's surface will result in higher attraction to the negatively charged bacterial membrane and better effects of the reactive oxygen species (ROS) as a component of its bactericidal/bacteriostatic mechanism. Moreover, Microwave assisted method is one of the most used approaches for CQDs preparation providing short response time and ensuring that the precursors are heated evenly resulting in highly efficient and uniform characteristics. This study utilized Guava leaf ethanolic extract as a source of CQD (G-CQDs) and Urea as a doping agent to produce doped CQDs (U-GCQDs) via Microwave assisted approach. Results show that IR spectra on GCQDs and U-GCQDs revealed vibrational molecules of C, H, and O which were evident to all CQD based materials. In addition, further confirmation of amine and amide groups on the U-GCQDs as a result of doping was observed in UV-Vis spectra. These results were found to be relevant to the antimicrobial effects exhibited against gram-negative and gram-positive, E. coli and S. aureus, respectively.

INTRODUCTION

Extensive use of antibiotics such as fluoroquinolones, chloramphenicol, trimethoprim and various carbapenem and β-lactam exacerbated antibiotic resistance resulting in drug-resistant strains due to rapid microorganism's mutation. One promising development against pathogens is the derivation and use organic compounds as nanomaterial precursors. It has high biocampatibility and low cytotoxicity and with proven antimicrobial properties due to the generation of reactive oxygen species (ROS) on bacterial's cell membrane.





METHODS

RESULTS

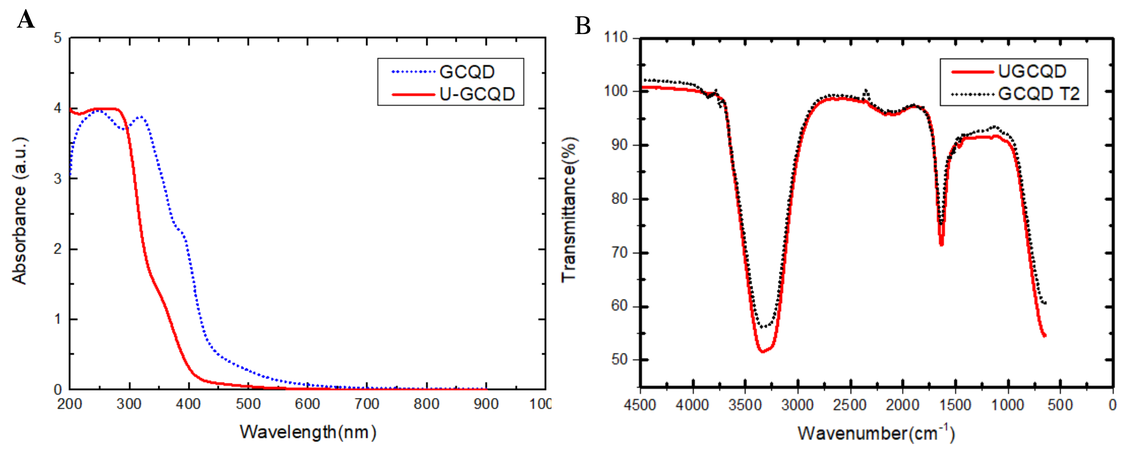
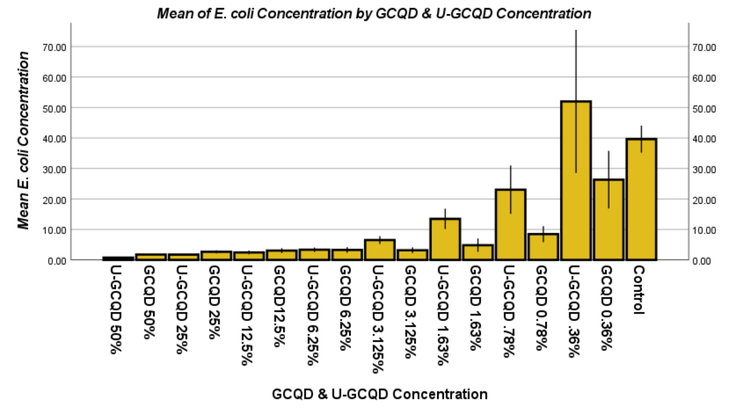


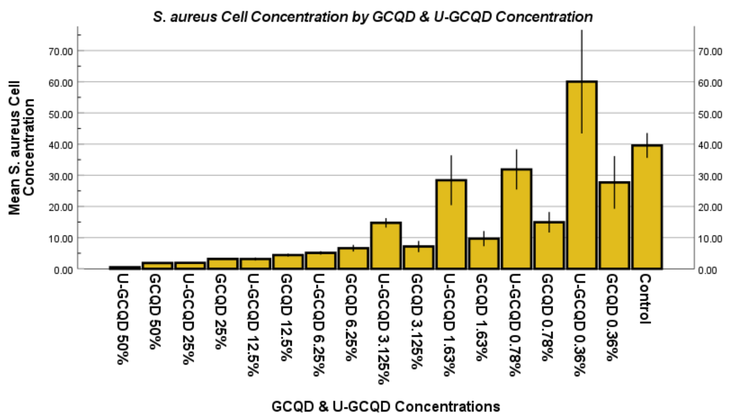
Figure 1. (A) The observed blueshift in the absorbance spectra of the UGCQD indicated that the molecule in the solution interacted more in the ground state than in the excited stated which is an obvious effect of the doping agent. (B) Weak vibrational molecules found in the FTIR spectra showed that nitrogen doping was successfully achieved.

Table 1. Shows the summary of antibacterial property for both GCQD and U-GCQD against E. coli and S. aureus. (A) Effects of carbon quantum dot against E. coli, where a decrease in bacterial cell concentration was significantly observed from the control down to the 50% GCQD and U-GCQD concentration. (B) Effects of carbon quantum dot against a gram positive S. aureus. A significant decrease in bacterial cell concentration observed from the control versus 50% GCQD and U-GCQD concentration.

A



B



CONCLUSIONS

- Doping of Urea on GCQD was succesful as shown by weak vibrational molecules found in the FTIR .
- Both GCQD and U-GCQD have significant antimicrobial effect as compared to the control, resulting to a decrease in bacterial cell concentration for both E. *coli* and S. *aureus*.
- Doping was successful but the antimicrobial property of GCQD was not increased with the dopant urea forming U-GCQD.