



SINTESIS KARBON DOT DARI LIMBAH PLASTIK SEBAGAI FOTOSENSITISER UNTUK TERAPI FOTODINAMIK

Lilia Setya Wahyuni
24/550115/PPA/06948

INTISARI

Akumulasi limbah plastik menimbulkan dampak negatif bagi lingkungan dan kesehatan, sehingga diperlukan upaya konversi limbah menjadi material fungsional seperti karbon dot (CDs). Penelitian ini bertujuan mensintesis CDs dari limbah plastik melalui metode kombinasi pirolisis dan sonikasi, serta mengevaluasi pengaruh jenis polimer limbah plastik, durasi pirolisis, jenis pelarut, serta daya dan durasi sonikasi terhadap karakteristik optik CDs. Karakterisasi CDs dilakukan menggunakan spektrofotometer UV-Vis, fluoresensi, spektrometer *Fourier Transform Infrared* (FTIR) dan Raman, *X-ray diffraction* (XRD), Zetasizer, serta *transmission electron microscope* (TEM). Selanjutnya, kinerja CDs sebagai agen fotosensitizer dalam terapi fotodinamik (PDT) diuji melalui pembentukan *Reactive Oxygen Species* (ROS) jenis oksigen singlet ($^1\text{O}_2$) menggunakan *probe* 1,3-difenillisobenzofuran (DPBF).

Hasil penelitian menunjukkan bahwa kondisi sintesis optimum dicapai melalui pirolisis limbah plastik selama 5 jam, diikuti sonikasi prekursor *polyethylene* (PE) konsentrasi 2,0% (b/v) dalam pelarut etanol (EtOH) pada daya 120 W selama 60 menit. CDs-PE EtOH yang dihasilkan memancarkan pendaran biru dengan *Quantum Yield* (QY) sebesar 14,48%. Analisis struktural mengonfirmasi morfologi kuasi-sferis berdiameter 3,64 nm dengan struktur amorf grafitik (bidang 002). Spektra Raman menunjukkan rasio intensitas I_D/I_G sebesar 2,97 yang mengindikasikan tingginya tingkat ketidakteraturan (*disorder*) struktur. CDs-PE EtOH menunjukkan aktivitas pembentukan ROS tertinggi dengan konstanta laju (k) $7,99 \times 10^{-2} \text{ min}^{-1}$. Tingginya rasio I_D/I_G serta keberadaan gugus fungsi karbonil permukaan terbukti berkontribusi signifikan terhadap efisiensi pembentukan ROS, menjadikan CDs-PE EtOH kandidat potensial sebagai agen fotosensitizer untuk aplikasi PDT.

Kata kunci: fotosensitizer, karbon dot, plastik, terapi fotodinamik.



SYNTHESIS OF CARBON DOTS FROM PLASTIC WASTE AS A PHOTSENSITIZER FOR PHOTODYNAMIC THERAPY

Lilia Setya Wahyuni
24/550115/PPA/06948

ABSTRACT

The accumulation of plastic waste poses a negative impact on the environment and human health, thus necessitating the conversion of waste into functional materials such as Carbon Dots (CDs). This study aimed to synthesize CDs from plastic waste via a combined pyrolysis and sonication method, and to evaluate the effects of plastic polymer type, pyrolysis duration, solvent type, as well as sonication power and duration on the optical characteristics of the CDs. Material characterization was performed using UV-Vis and fluorescence spectrophotometers, Fourier Transform Infrared (FTIR) and Raman spectrometers, X-ray diffraction (XRD), Zetasizer, and transmission electron microscopy (TEM). Furthermore, the performance of the CDs as photosensitizers in Photodynamic Therapy (PDT) was evaluated through the generation of Reactive Oxygen Species (ROS), specifically singlet oxygen ($^1\text{O}_2$), using 1,3-diphenylisobenzofuran (DPBF) probe.

The results indicated that the optimum synthesis conditions were achieved through the pyrolysis of plastic waste for 5 hours, followed by the sonication of polyethylene (PE) precursor at a concentration of 2.0% (w/v) in ethanol (EtOH) solvent at 120 W for 60 minutes. The resulting CDs-PE EtOH exhibited blue fluorescence emission with a Quantum Yield (QY) of 14.48%. Structural analysis confirmed a quasi-spherical morphology with a diameter of 3.64 nm and a graphitic amorphous structure (002 plane). Raman spectra showed an I_D/I_G intensity ratio of 2.97, indicating a high degree of structural disorder. The CDs-PE EtOH demonstrated the highest ROS generation activity with a rate constant (k) of 7.99 min^{-1} . The high I_D/I_G ratio and the presence of surface carbonyl functional groups were proven to contribute significantly to the ROS generation efficiency, positioning CDs-PE EtOH as a potential candidate as a photosensitizer for PDT applications.

Keywords: carbon dots, photosensitizer, photodynamic therapy, plastic.