

Sintesis Karbon Dots Terdoping Nitrogen dan Fosfor Termodifikasi Ampisilin (N,P-CDs@Ampisilin) Sebagai Sensor Bakteri *Escherichia coli* (*E. coli*)

Amalia Khoirunnisa

22/500612/PPA/06358

INTISARI

Pengembangan sensor karbon dots terdoping nitrogen dan fosfor termodifikasi antibiotik ampisilin (N,P-CDs@Ampisilin) dilakukan melalui metode *bottom-up microwave*. N,P-CDs@Ampisilin digunakan dalam deteksi bakteri *Escherichia coli* (*E. coli*) pada sampel air. Pada penelitian ini dilakukan beberapa optimasi, seperti optimasi daya iradiasi *microwave*, waktu iradiasi, massa dopan N dan P, volume etilendiamin, massa ampisilin. Daya, waktu, massa dopan, dan massa ampisilin yang optimal digunakan untuk sintesis N,P-CDs@Ampisilin dan selanjutnya dilakukan pengkajian terhadap stabilitas N,P-CDs@Ampisilin, sensitivitas, dan selektivitas terhadap bakteri Gram negatif dan Gram positif. Pada tahap ini, semua kondisi optimal N,P-CDs@Ampisilin akan digunakan untuk deteksi *E. coli* pada sampel air.

Keberhasilan sintesis N,P-CDs@Ampisilin didasarkan pada spektra FTIR, ditunjukkan bahwa atom N dan P telah berhasil terpasivasi pada permukaan karbon dots dengan keberadaan vibrasi karakteristik C-N, C-P, serta C-S dari ampisilin. Hasil spektra UV-Vis menunjukkan terbentuk transisi elektronik $\pi \rightarrow \pi^*$ untuk ikatan C=C aromatik serta transisi elektronik $n \rightarrow \pi^*$ untuk ikatan C-N dan C=O karbonil. Hasil spektra Raman menunjukkan bahwa *defect* berhasil dilakukan karena nilai rasio ID/IG dari karbon dots lebih kecil daripada rasio ID/IG N,P-CDs@Ampisilin. Hasil morfologi SEM-EDX menunjukkan pada modifikasi ampisilin berhasil dilakukan karena pada N,P-CDs@Ampisilin terdapat atom S dengan rasio 0,63%. Hasil difraktogram XRD terdapat sudut 2θ 28,79 dan 40,91° yang menunjukkan bidang hkl (002) dan (100), keduanya merupakan kisi karbon grafit. Hasil XRD diperkuat dengan HR-TEM yang diperoleh *lattice fringe* dan pola cincin SAED dengan jarak antar kisi 0,22 nm. Ukuran N,P-CDs@Ampisilin yang diperoleh adalah sebesar 3,68 nm dengan bentuk sferis atau bulat. Nilai LOD dan LOQ N,P-CDs@Ampisilin terhadap bakteri *E. coli* yang diperoleh adalah sebesar 1,657 cfu/mL dan 5,382 cfu/mL. N,P-CDs@Ampisilin stabil dalam penyimpanan selama 35 hari, paparan sinar UV selama 60 menit, kekuatan ionik, dan pH 4. N,P-CDs@Ampisilin selektif terhadap bakteri *E. coli* sehingga efektif digunakan untuk deteksi *E. coli* dalam sampel air.

Kata kunci: N,P-CDs@Ampisilin, *Microwave*, Fluoresensi, *Escherichia coli*

***SYNTHESIS OF NITROGEN AND PHOSPHORUS DOPED CARBON DOTS
MODIFIED WITH AMPICILLIN (N,P-CDs@AMPICILLIN) AS AN
Escherichia coli (E. coli) BACTERIA SENSORS***

Amalia Khoirunnisa

22/500612/PPA/06358

ABSTRACT

The development of nitrogen and phosphorus doped carbon dot sensors modified by the antibiotic ampicillin (N,P-CDs@Ampicillin) was carried out using the bottom-up microwave method. N,P-CDs@Ampicillin is used in the detection of *Escherichia coli* (*E. coli*) bacteria in water samples. In this research, several optimizations were carried out, such as optimization of microwave irradiation power, irradiation time, mass of N and P dopants, volume of ethylenediamine, mass of ampicillin. Optimal power, time, dopant mass and ampicillin mass were used for the synthesis of N,P-CDs@Ampicillin and then an assessment was carried out on the stability of N,P-CDs@Ampicillin, sensitivity and selectivity against Gram-negative and Gram-positive bacteria. At this stage, all optimal conditions of N,P-CDs@Ampicillin will be used for the detection of *E. coli* in water samples

The success of the synthesis of N,P-CDs@Ampicillin is based on FTIR spectra, indicating that N and P atoms have been successfully passivated on the surface of the carbon dots with the presence of characteristic C-N, C-P, and C-S vibrations from ampicillin. The UV-Vis spectra results show that a $\pi \rightarrow \pi^*$ electronic transition is formed for aromatic C=C bonds and $n \rightarrow \pi^*$ electronic transition for carbonyl C-N and C=O bonds. Raman spectra results indicate that defects were successfully introduced, as the ID/IG ratio of carbon dots is lower than the ID/IG ratio of N,P-CDs@Ampicillin. SEM-EDX morphology results show that ampicillin modification was successful, as N,P-CDs@Ampicillin contains S atoms with a ratio of 0.63%. XRD diffractogram results show angles of 2θ 28.79 and 40.91° indicating (002) and (100) hkl planes, both representing graphite carbon lattices. XRD results are reinforced by HR-TEM, which shows lattice fringes and SAED ring patterns with an inter-lattice distance of 0.22 nm. The obtained size of N,P-CDs@Ampicillin is 3.68 nm with a spherical shape. The LOD and LOQ values of N,P-CDs@Ampicillin for *E. coli* bacteria are 1.657 cfu/mL and 5.382 cfu/mL, respectively. N,P-CDs@Ampicillin is stable during storage for 35 days, under UV exposure for 60 minutes, ionic strength, and pH 4. N,P-CDs@Ampicillin is selective towards *E. coli* bacteria, making it effective for detecting *E. coli* in water sample.

Keywords: N,P-CDs@Ampicillin, Microwave, Fluorescence, *Escherichia coli*