

Supplementary information
For
Interfacial Electron Transfer-Assisted Activation of
Peroxydisulfate] by CuO/Biochar for Efficient Ciprofloxacin
Degradation: Mechanistic Insights and Application in Permeable
Reactive Barriers

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Table S1. Operating parameters for the main characterization techniques

Technique	Instrument	Operating Parameters
XRD	Bruker D8 Advance	Cu K α radiation ($\lambda = 1.5406 \text{ \AA}$); 40 kV, 40 mA; 2 θ range: 10-80°; step size: 0.02°; scan speed: 2° min ⁻¹ .
SEM	Hitachi Regulus 8100	Acceleration voltage: 5 kV; working distance: 8 mm; gold sputter coating for 60 s.
BET	Micromeritics ASAP2460	N ₂ adsorption–desorption at 77 K; degassing at 200 °C for 6 h under vacuum.
XPS	Thermo Scientific ESCALAB 250Xi	Monochromatic Al K α X-ray source (1486.6 eV); pass energy: 50 eV (high-resolution spectra); binding energy calibrated with C 1s peak at 284.8 eV.
EPR	JEOL JES-FA200	Microwave frequency: 9.4 GHz; power: 1 mW; modulation frequency: 100 kHz; modulation amplitude: 0.2 mT; spin traps: DMPO (for radicals) and TEMP (for ¹ O ₂).

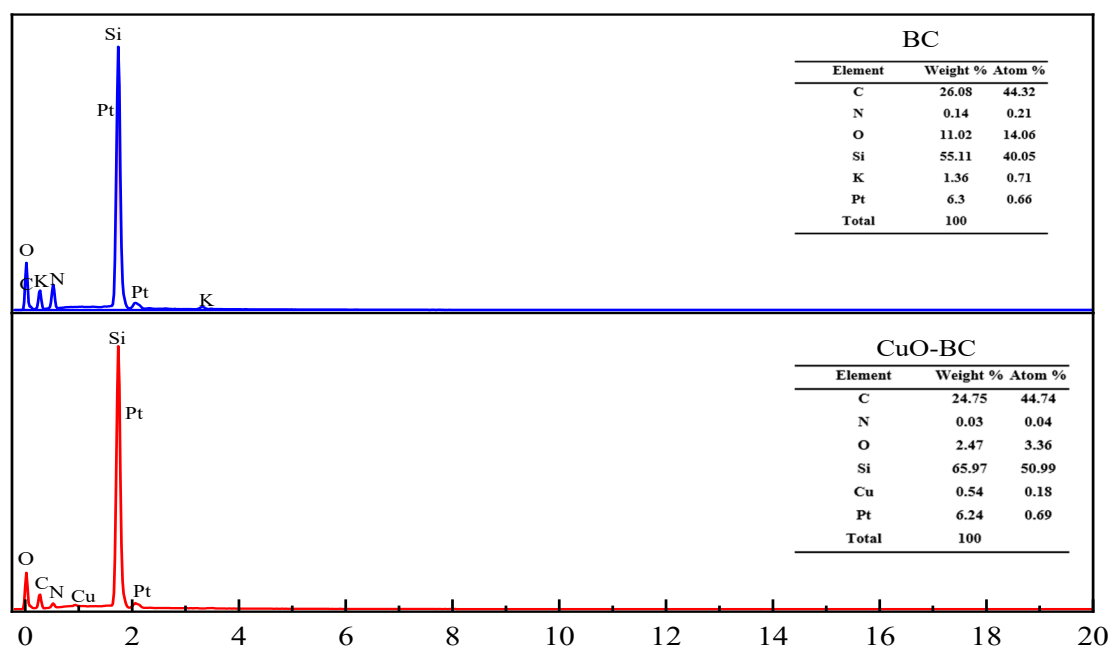


Figure S1. EDS mapping of CuO-BC.

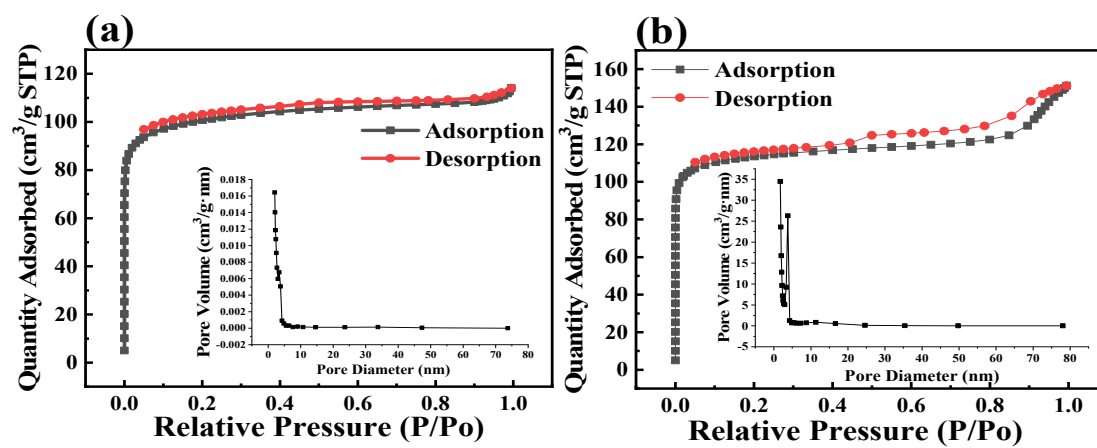


Figure S2. The adsorption/desorption isotherm of BC (a) and CuO-BC (b).

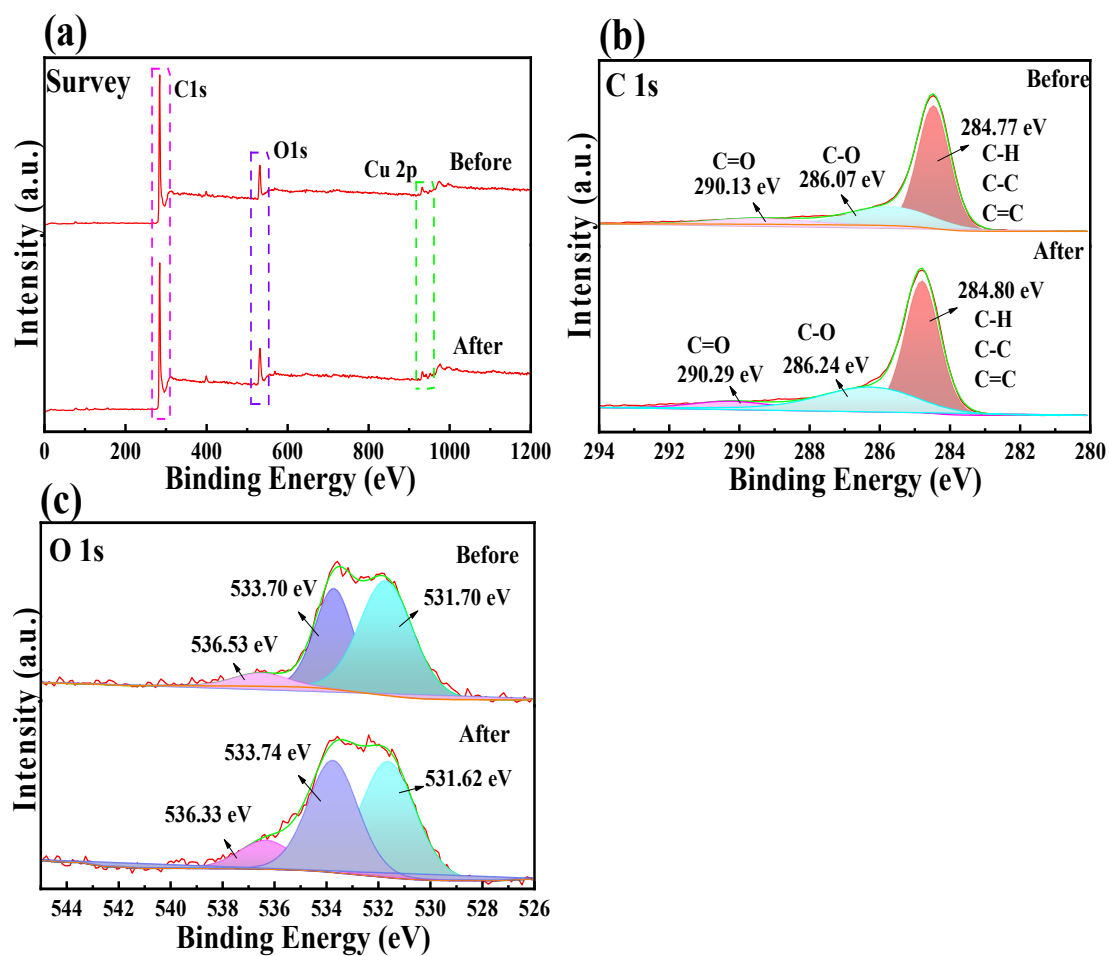


Figure S3. XPS spectra of CuO-BC before and after the reaction: (a) survey scan , (b) C1s and (c) O1s.

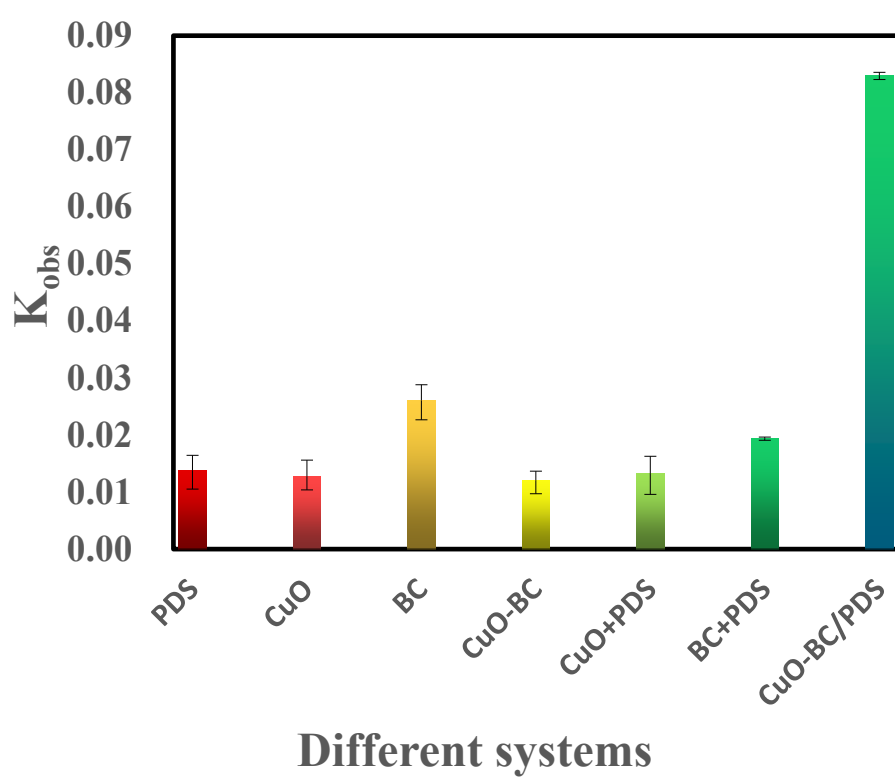


Figure S4. The observed pseudo first-order rate constant of Fig.5.

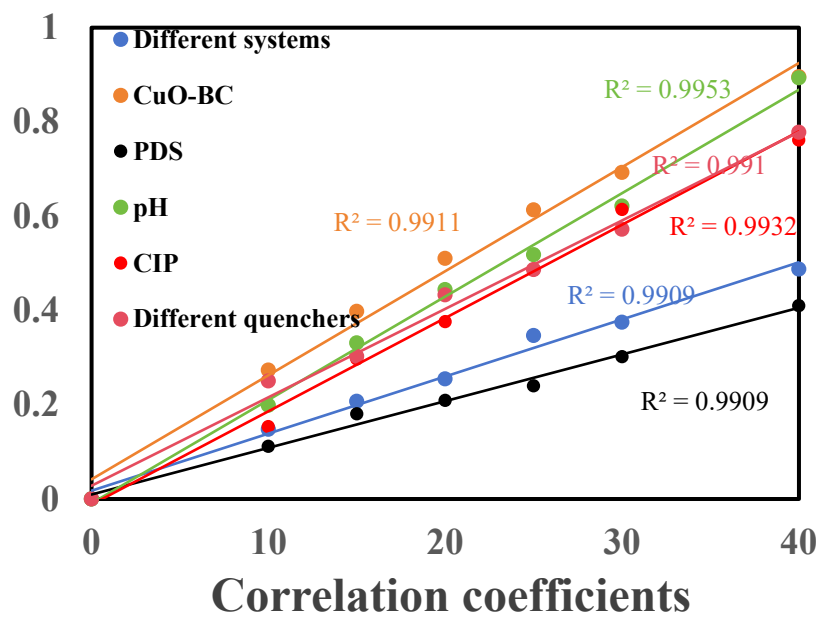


Figure S5. Correlation coefficients R^2 .

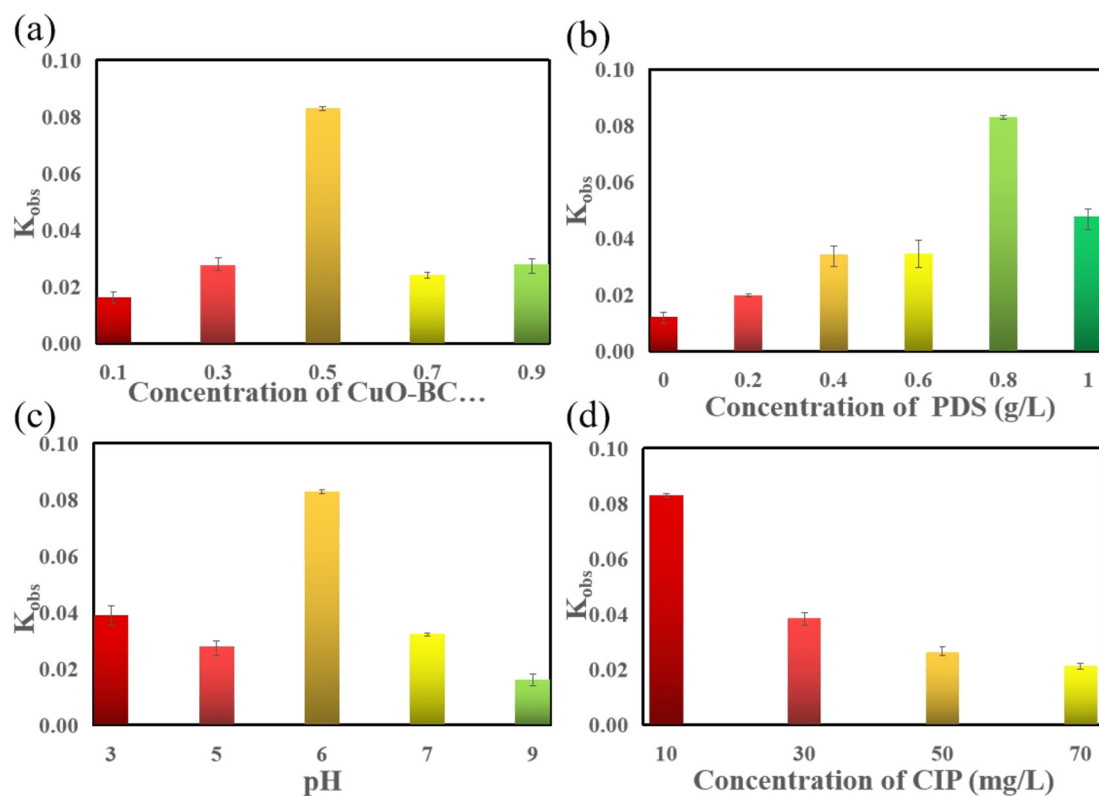


Figure S6. (a) The observed pseudofirst-order rate constant of Fig.6a; (b) The observed pseudofirst-order rate constant of Fig.6b; (c) The observed pseudofirst-order rate constant of Fig.6c; (d) The observed pseudofirst-order rate constant of Fig.6d.

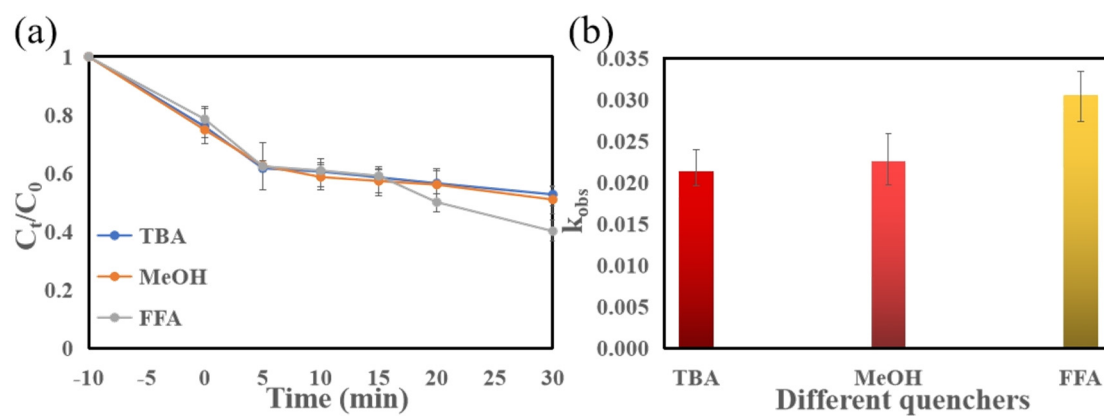


Figure S7. (a) Effect of different quenchers on the degradation efficiency of CIP; (b) The observed pseudofirst-order rate constant of (a).

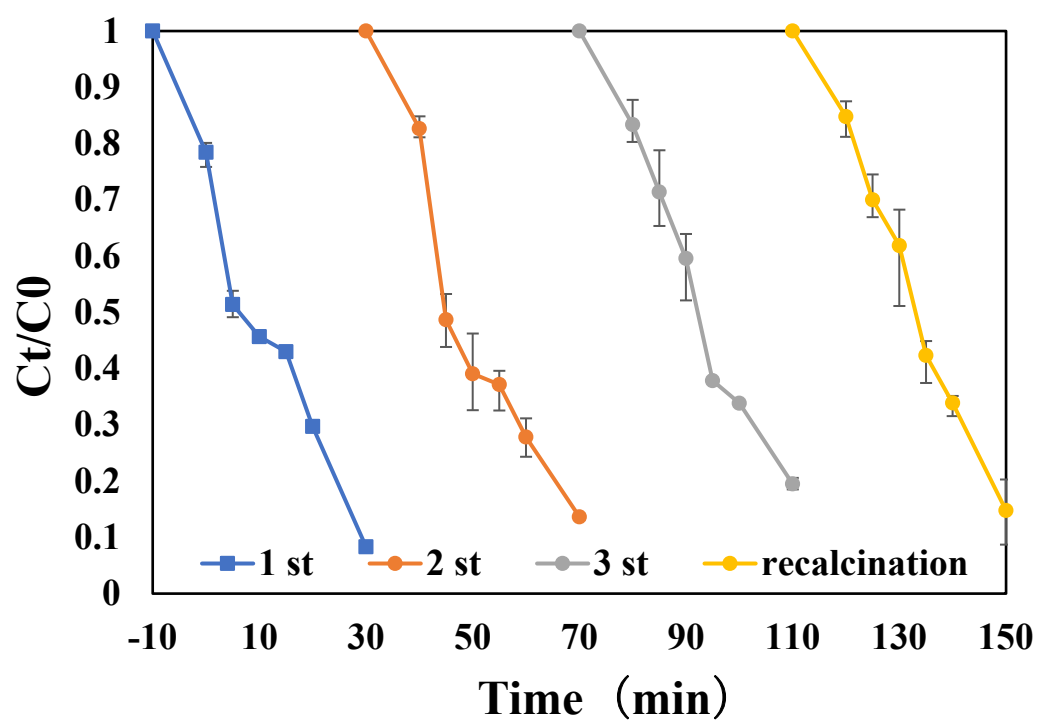


Figure S8. Recycle experiments for the CIP degradation by CuO-BC/PDS.

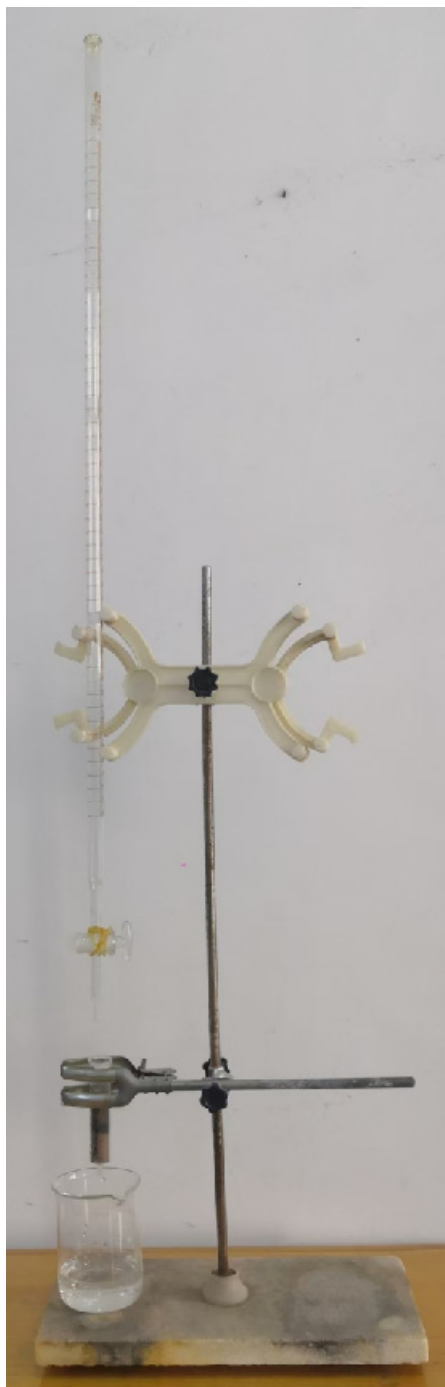


Figure S9. Experimental setup for PRB.

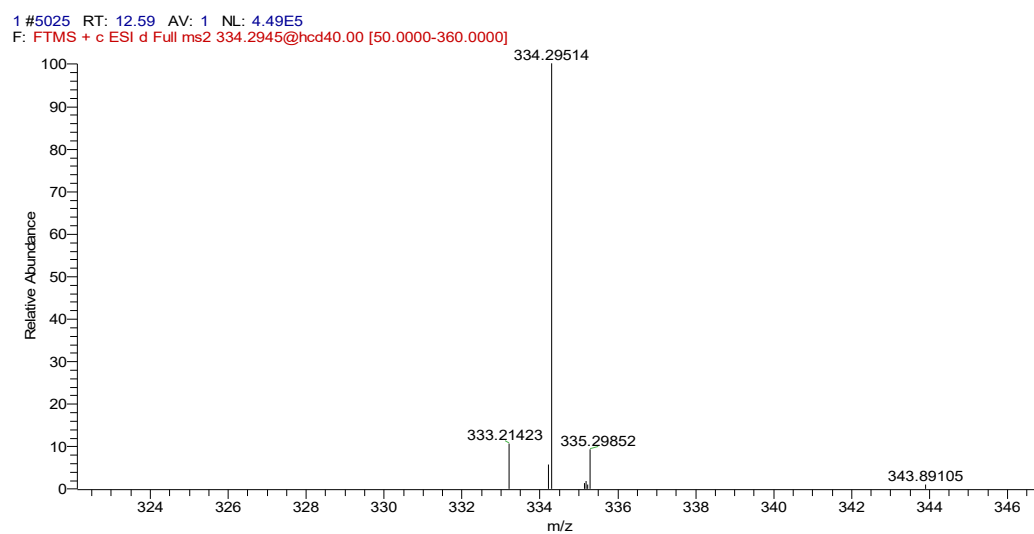


Figure S10. LC-MS spectra of CIP degradation intermediate P1 ($m/z=334$).

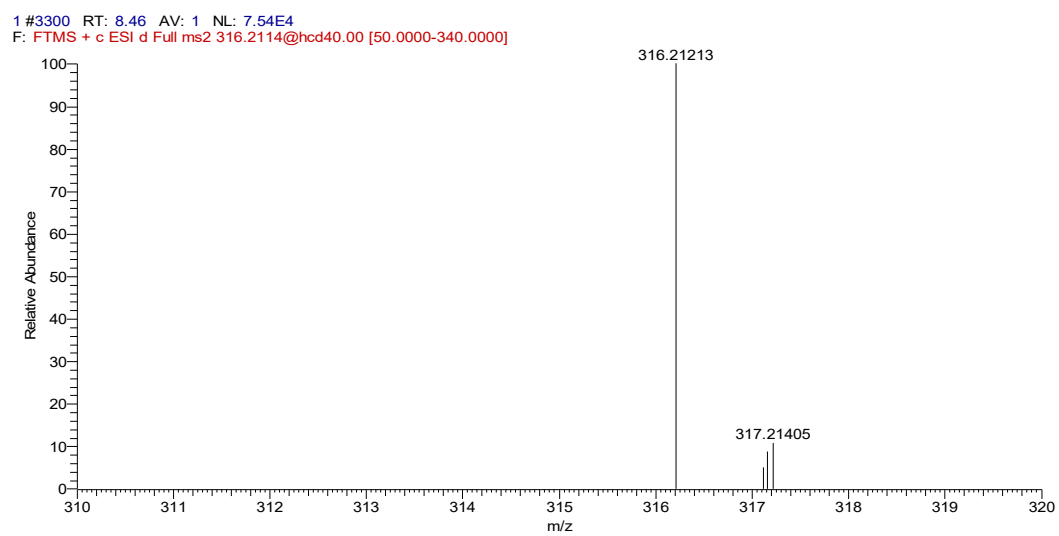


Figure S11. LC-MS spectra of CIP degradation intermediate P2 ($m/z=316$).

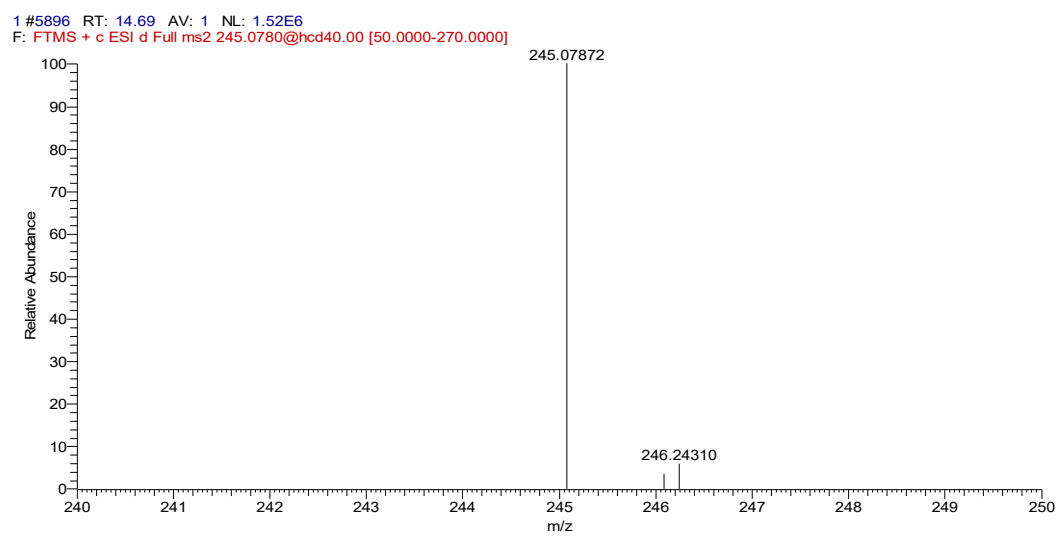


Figure S12. LC-MS spectra of CIP degradation intermediate P3 ($m/z=245$).

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F: FTMS + c ESI d Full ms2 362.1905@hcd40.00 [50.6667-760.0000]

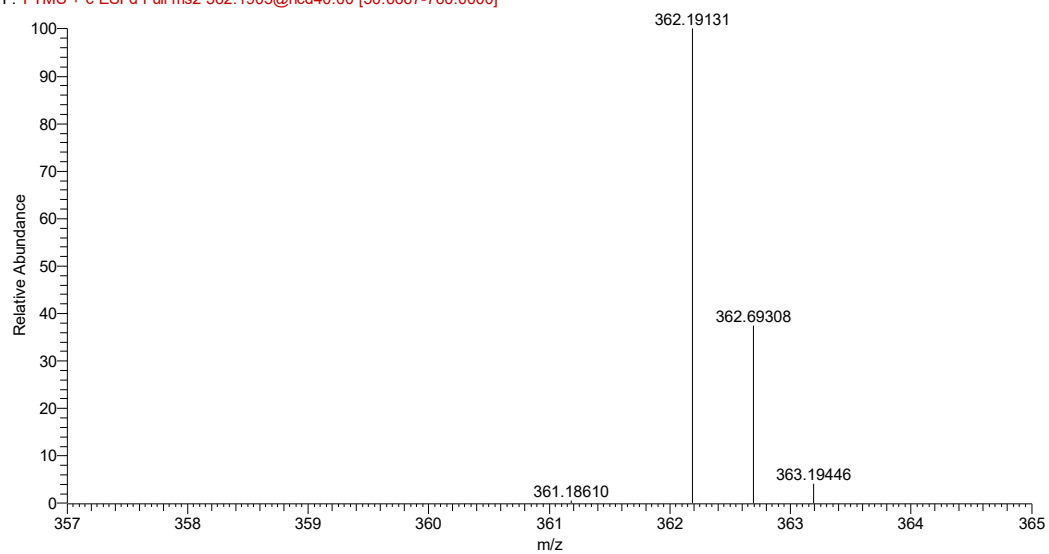


Figure S13. LC-MS spectra of CIP degradation intermediate P4 ($m/z=362$).

1 #4759 RT: 11.96 AV: 1 NL: 5.01E5
F: FTMS + c ESI d Full ms2 334.2945@hcd40.00 [50.0000-360.0000]

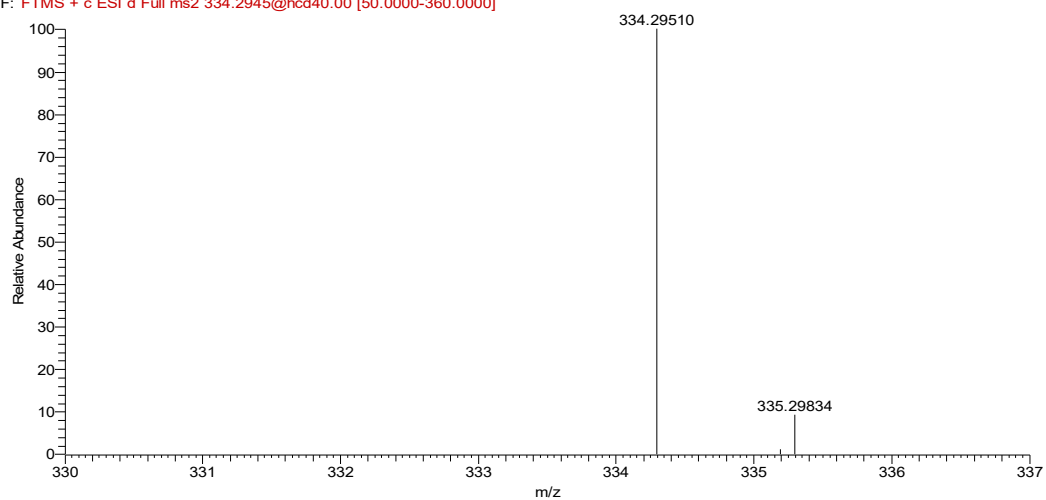


Figure S14. LC-MS spectra of CIP degradation intermediate P5 ($m/z=334$).

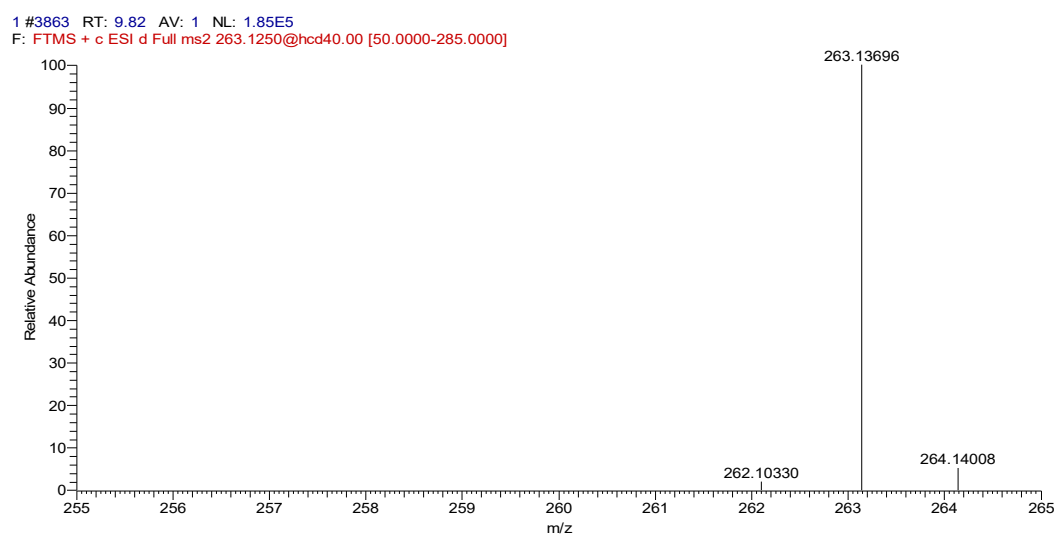


Figure S15. LC-MS spectra of CIP degradation intermediate P6 ($m/z=263$).

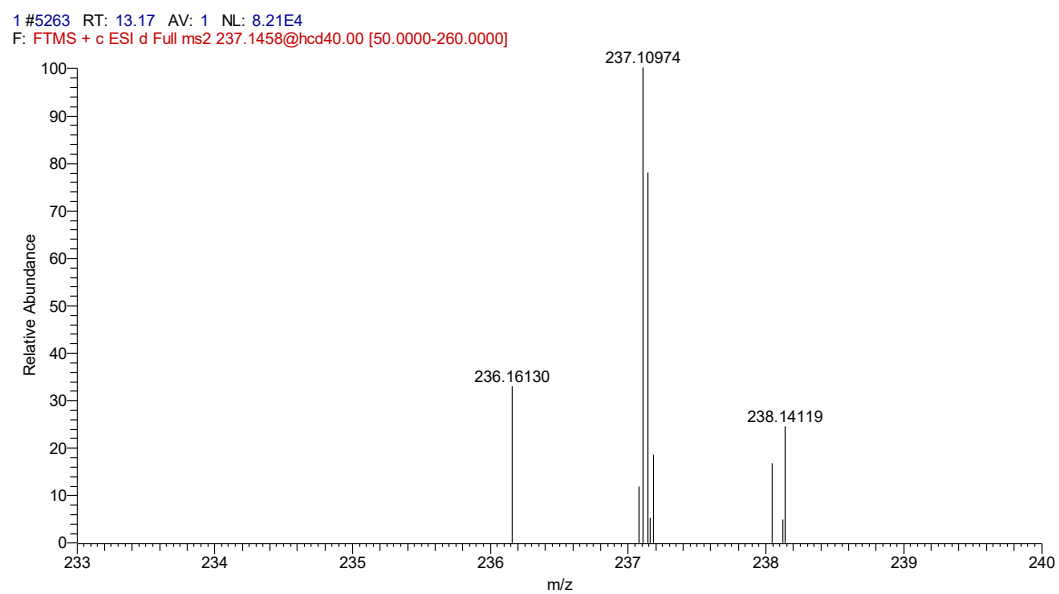


Figure S16. LC-MS spectra of CIP degradation intermediate P7 ($m/z=237$).

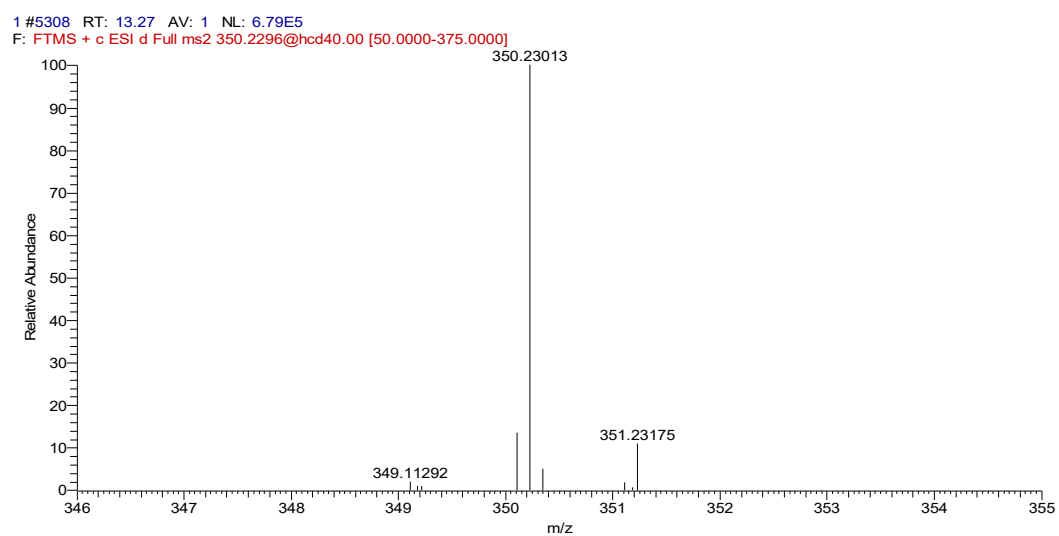


Figure S17. LC-MS spectra of CIP degradation intermediate P8 ($m/z=350$).

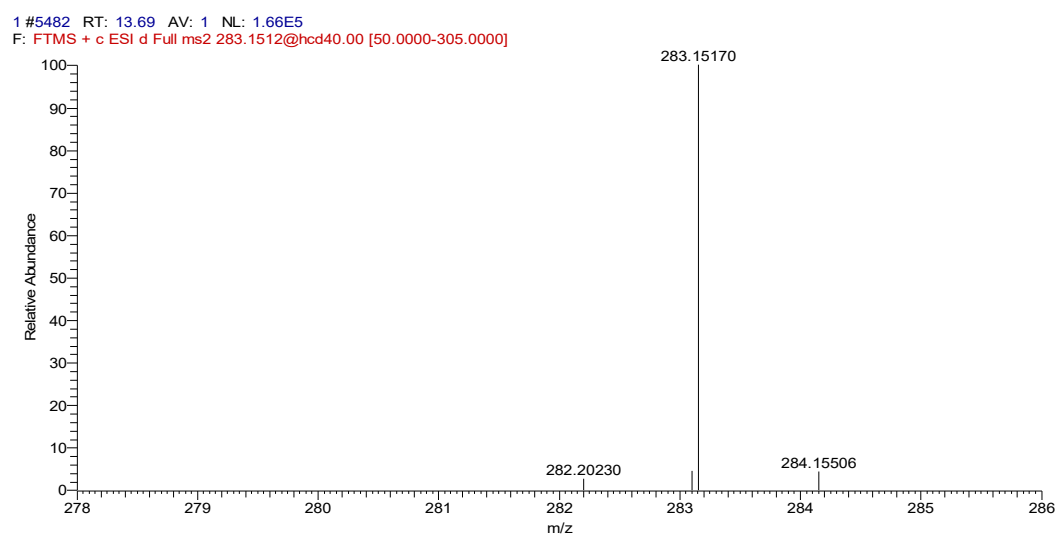


Figure S18. LC-MS spectra of CIP degradation intermediate P9 ($m/z=283$).

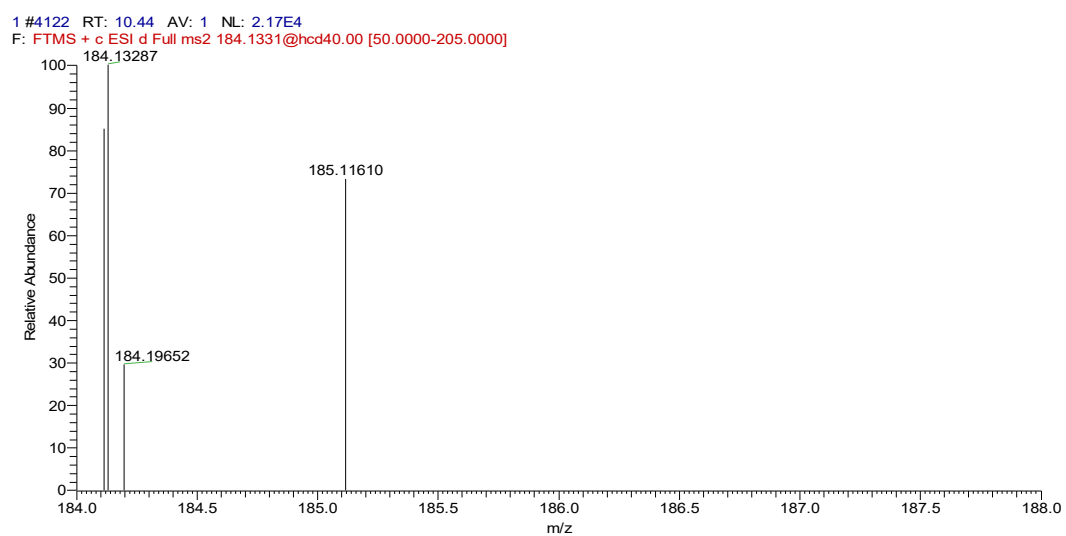


Figure S19. LC-MS spectra of CIP degradation intermediate P10 ($m/z=184$).