SUPPLEMENTARY MATERIAL

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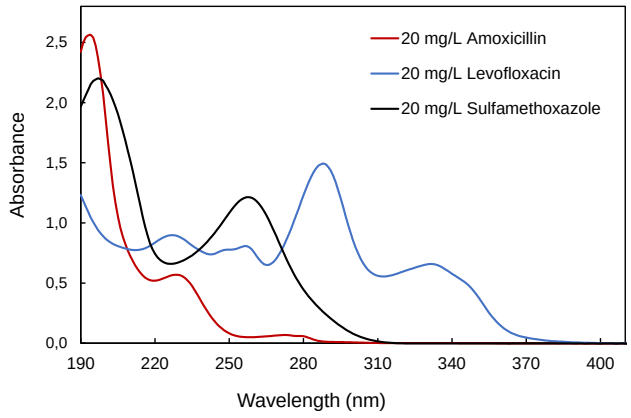
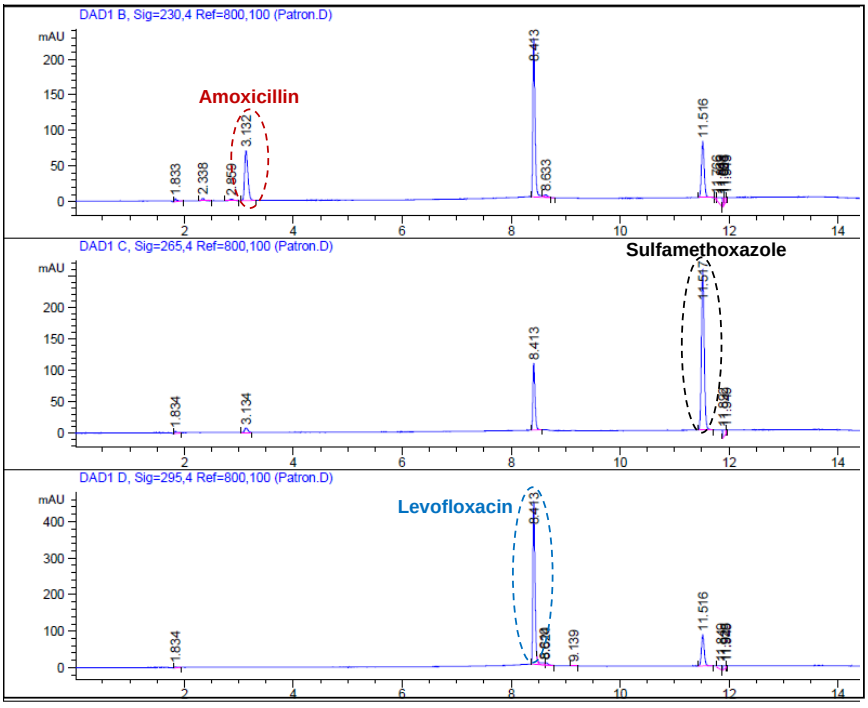




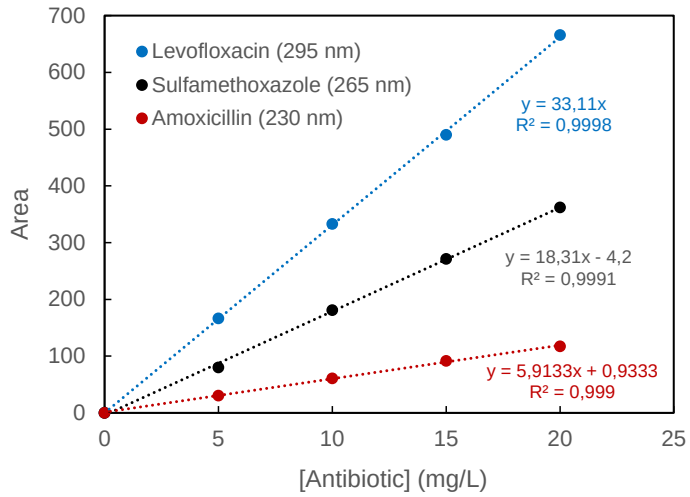


Figure S1. Spectra of antibiotics, a typical HPLC chromatogram, and HPLC quantification curves

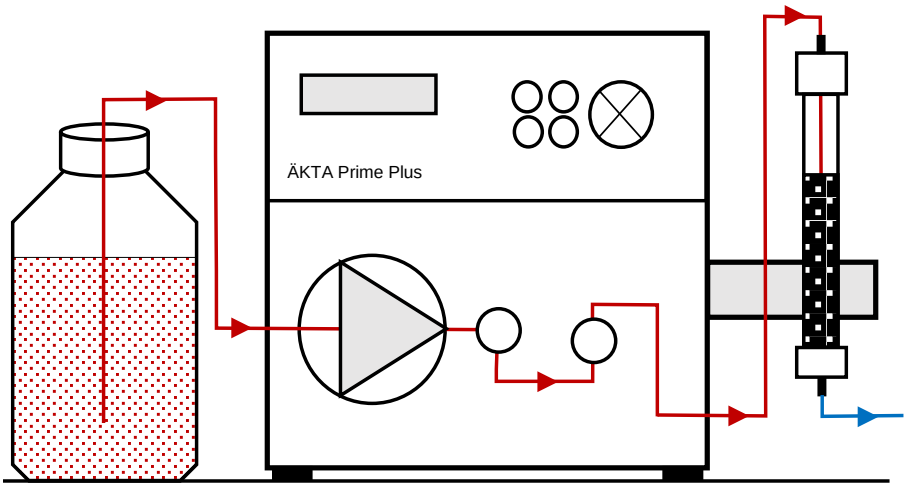
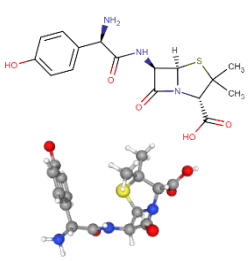
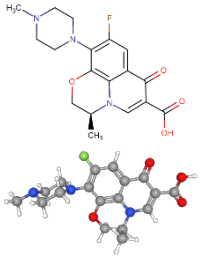
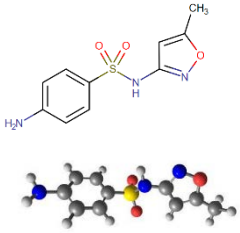


Figure S2. Experimental set-up of the studied fixed bed adsorber

Table S1. Antibiotic properties.

Property	Amoxicillin	Levofloxacin	Sulfamethoxazole
Chemical structure			
Molecular formula	$C_{16}H_{19}N_3O_5S$	$C_{18}H_{20}FN_3O_4$	$C_{10}H_{11}N_3O_3S$
M (g/mol)	365.4	361.4	253.3
Polar surface area (Å^2)	132.9	73.3	107
Melting point (ºC)	194	220-225	166-169
Water solubility (mg/L)	3430	1000	459
pKa_1 / pKa_2 / pKa_3	2.4 / 7.4 / 9.6 (carboxyl, amine, phenol)	6.1 / 8.1 (carboxyl, piperazine amine)	1.8 / 5.6 (amine, sulphonamide)

DrugBank Online | Database for Drug and Drug Target Info (Drugbank online)

PubChem (nih.gov) (Pubchem)

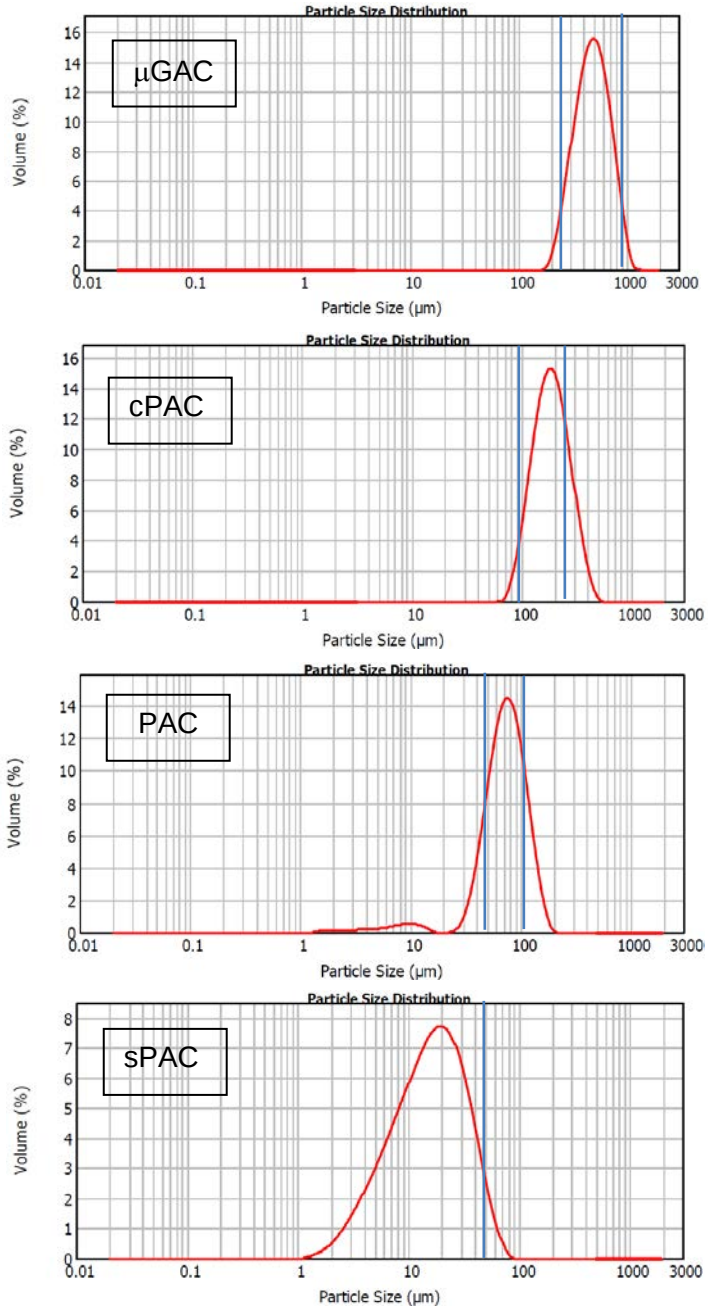


Figure S3. Particle size distribution curves of studied activated carbons.

Table S2. Parameters of particle size distributions of studied activated carbons.

Parameter	GAC	µGAC	cPAC	PAC	sPAC
D[4,3] (µm)	1500	508	197	77	19
Span	-	0.976	1.019	1.089	2.103
Uniformity	-	0.300	0.317	0.350	0.654

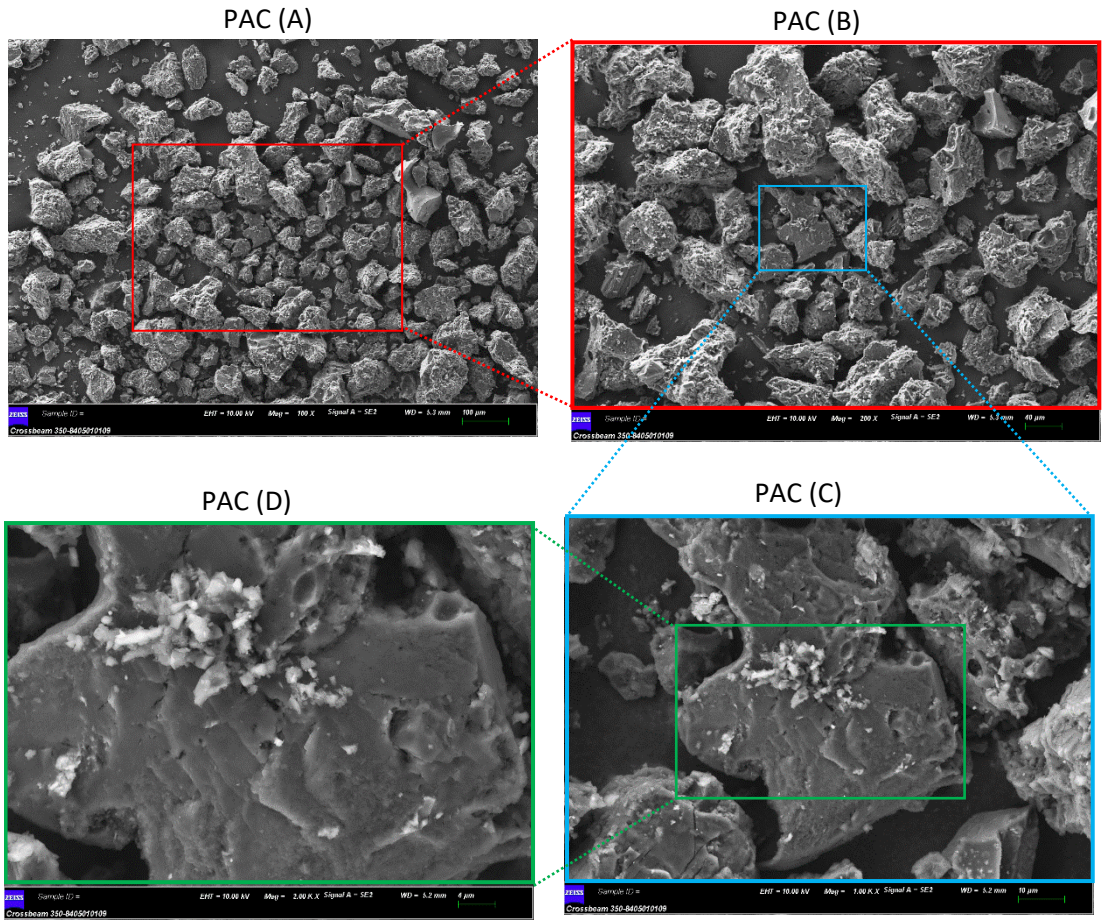


Figure S4. SEM images of PAC using different magnifications 100, 200, 1000 and 2000 (A, B, C, D).

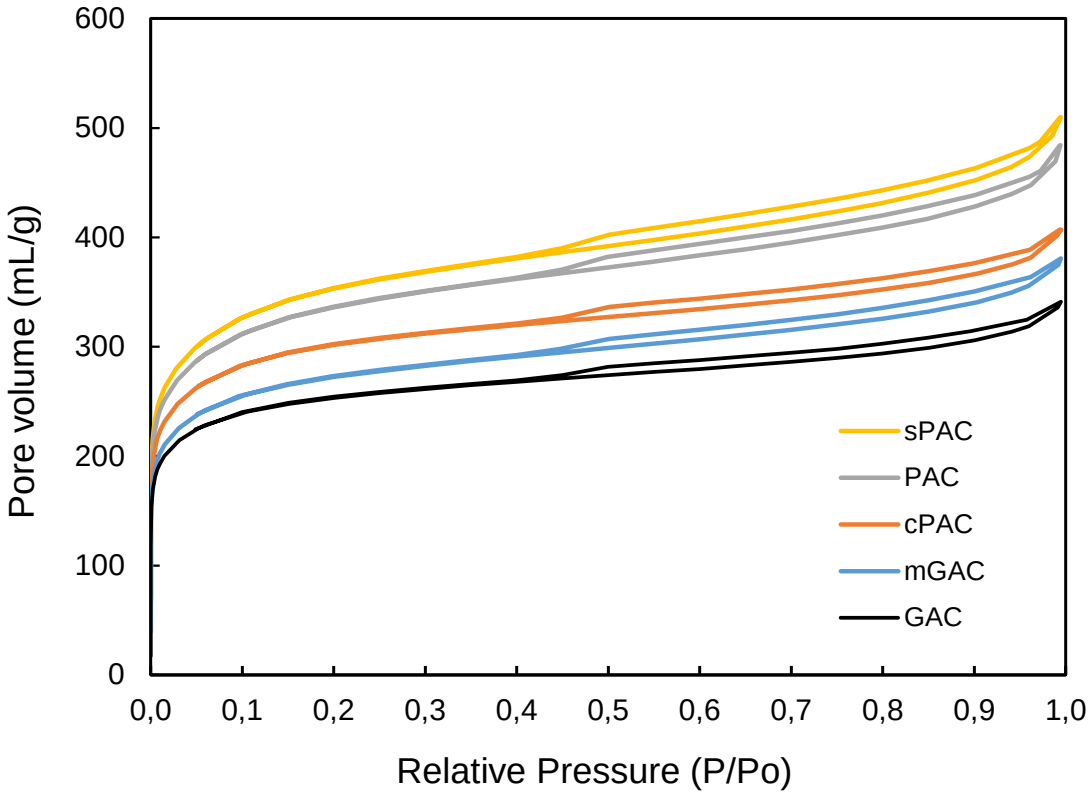


Figure S5. Adsorption-desorption isotherms of N_2 at 77 K

Table S3. Specific surface area and pore volumes of obtained activated carbons.

Parameter	GAC	μGAC	cPAC	PAC	sPAC
S_{BET} (m^2/g)	942	1014	1125	1245	1318
V_{total} (cm^3/g)	0.492	0.550	0.590	0.693	0.733
V_{micro} (cm^3/g)	0.353	0.375	0.410	0.444	0.468
V_{meso} (cm^3/g)	0.139	0.175	0.180	0.249	0.265

S_{BET} (m^2/g) = BET surface area
V_{micro} (cm^3/g) = micropore volume (DR)
V_{total} (cm^3/g) = total pore volume
V_{meso} (cm^3/g) = mesopore volume = V_{total} - V_{micro}

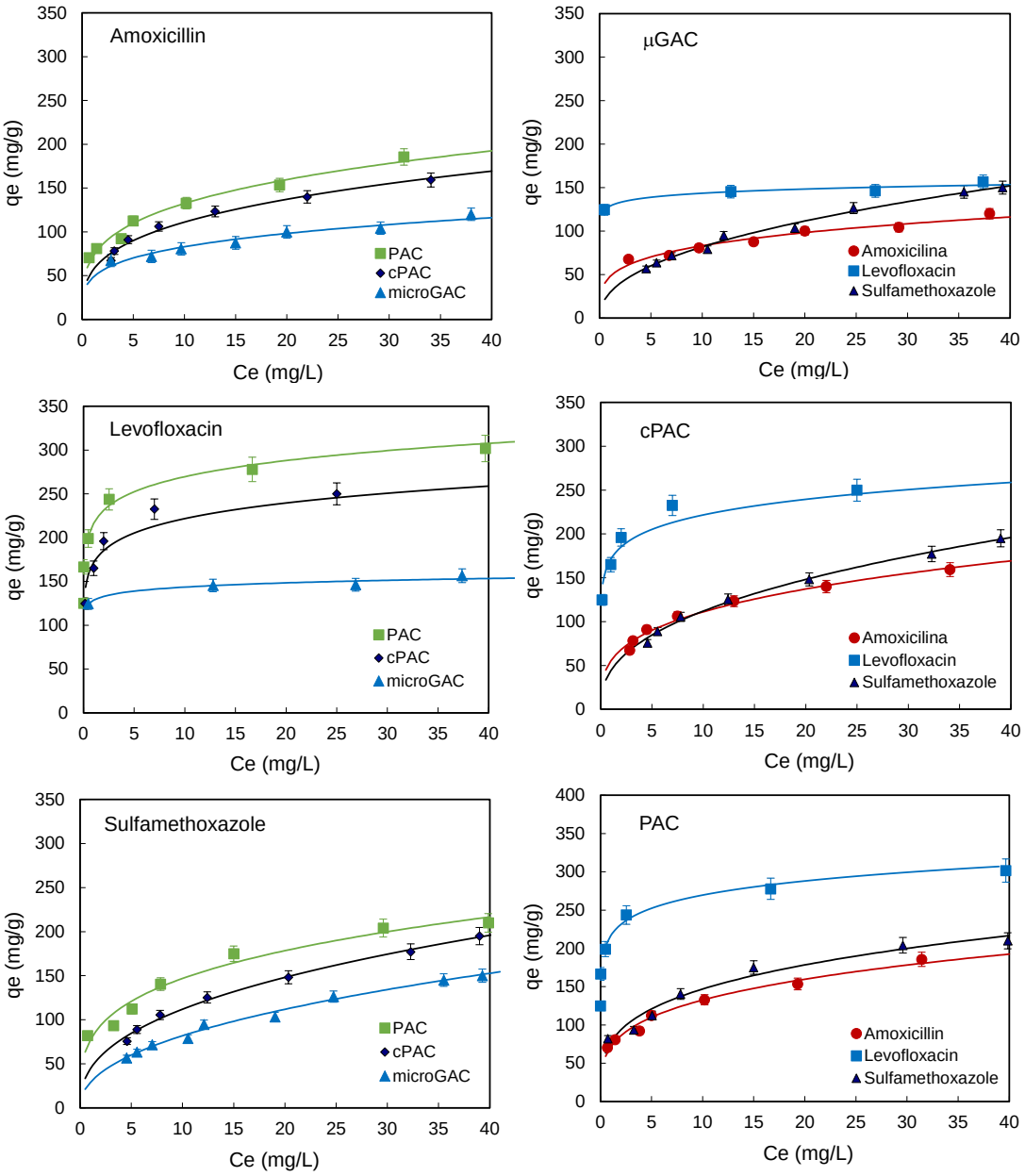


Figure S6. Isothermal adsorption of individual antibiotics on µGAC, cPAC, and PAC, fitted with Freundlich model.

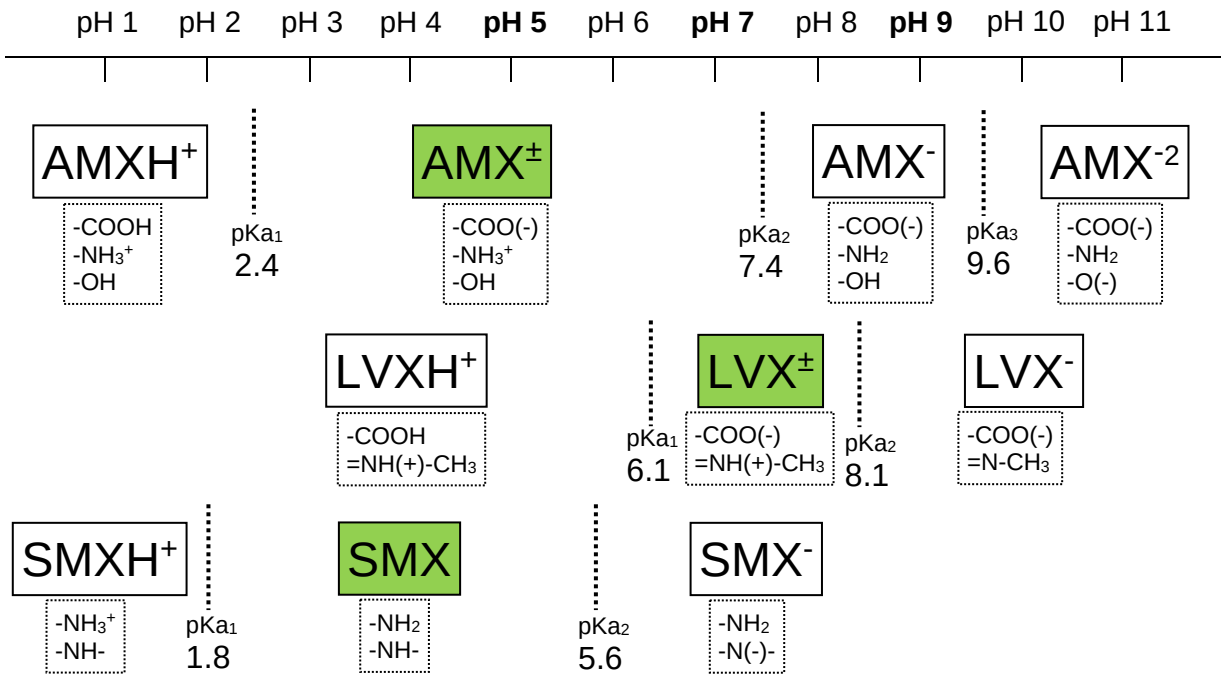


Figure S7. Distribution of molecular species at different pHs of amoxicillin (AMX), levofloxacin (LVX), and sulfamethoxazole (SMX). Green are structures at the pH of best adsorption.

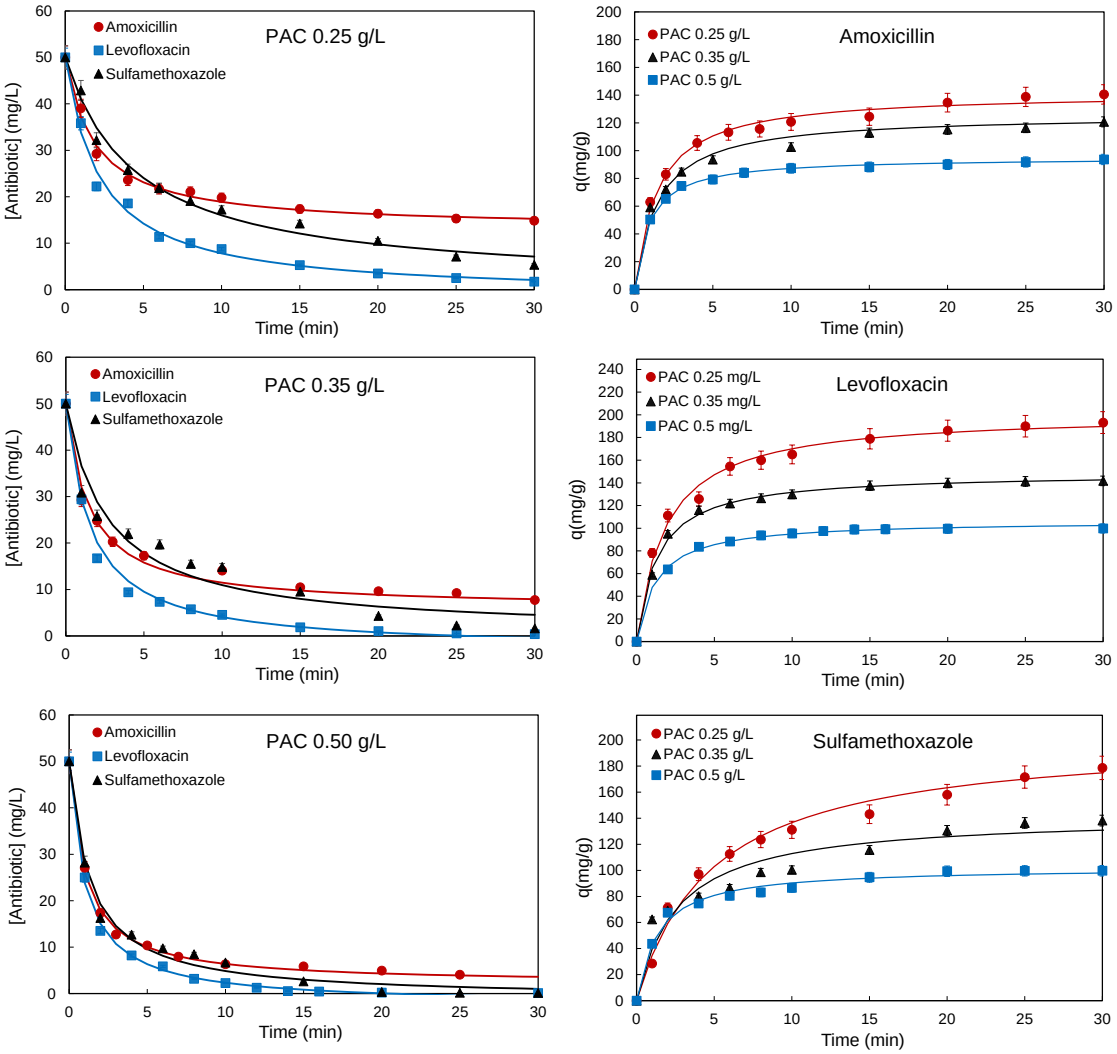


Figure S8. Antibiotics adsorption kinetics at pH 7 with different PAC concentrations, fitted with second-order kinetic model.

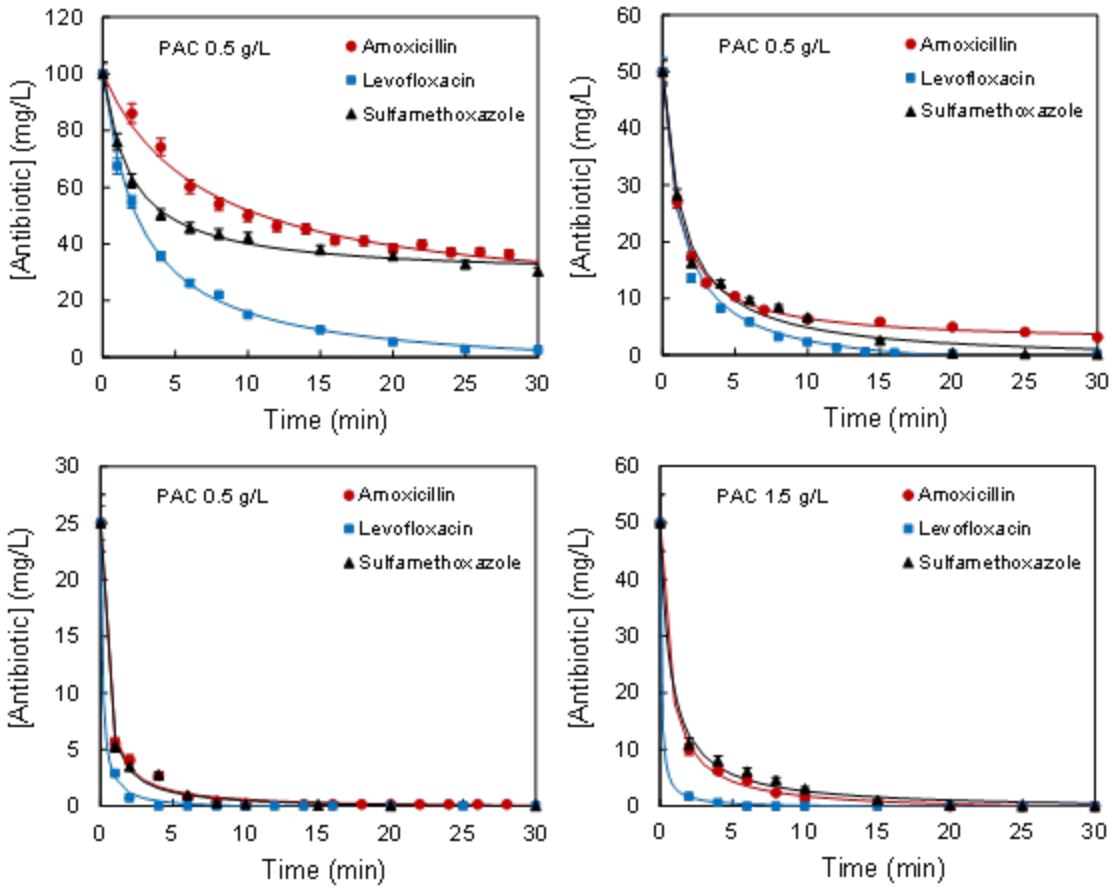


Figure S9. Adsorption kinetics at pH 7 with different individual antibiotic concentrations using 0.5 g/L PAC, and an antibiotic's mixture with 1.5 g/L PAC concentration. Data fitted with pseudo-second order model.

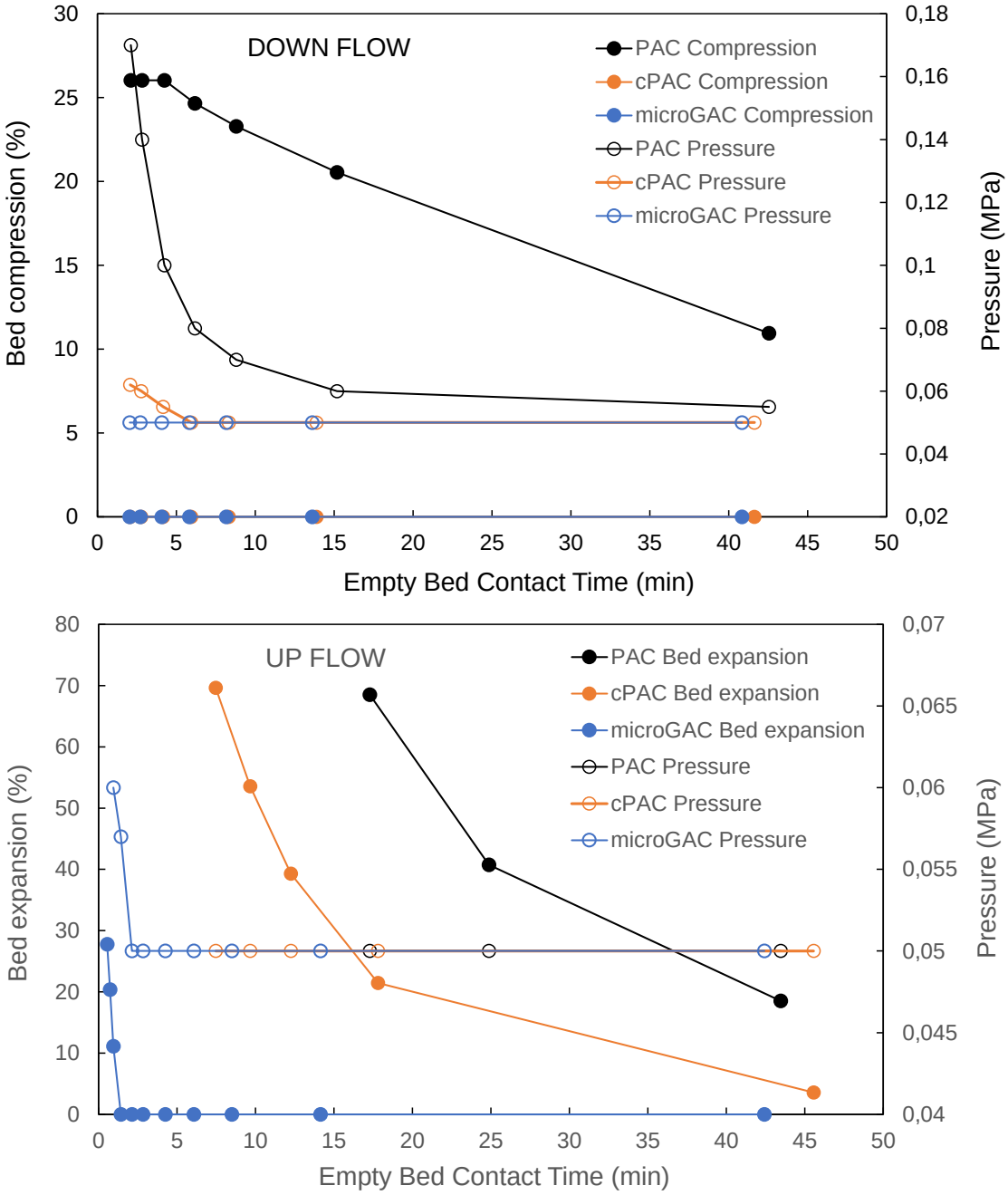


Figure S10. Evaluation of operation conditions of fixed bed adsorbers packed with different activated carbons: μGAC, cPAC and PAC.

Table S4. Wastewater analysis

Analytical parameter	Value
pH	7.0
Conductivity (μS/cm)	120.0
BOD_5 (mgO_2/L)	10
Turbidity (NTU)	1
Cl^- (mg/L)	44.24
Br^- (mg/L)	0.67
F^- (mg/L)	0.14
NO_3^- (mg/L)	14.29
NO_2^- (mg/L)	2.61
PO_4^{3-} (mg/L)	4.04
SO_4^{2-} (mg/L)	34.28
$C_2O_4^{2-}$ (mg/L)	<LD
Na^+ (mg/L)	28.29
K^+ (mg/L)	5.78
Li^+ (mg/L)	<LD
Ca^{2+} (mg/L)	36.76
Mg^{2+} (mg/L)	6.81
NH_4^+ (mg/L)	1.23
Total Inorganic Carbon (mg/L)	12.22
Total Organic Carbon (mg/L)	4.79
Total Carbon (mg/L)	16.67
Total Nitrogen (mg/L)	5.68

Table S5. Modelling breakthrough curves of fixed bed adsorbers packed with μGAC or cPAC using deionized water with 50 mg/L antibiotic concentrations as influent.

Activated carbon	Model	Model parameter	Antibiotic		
			Amoxicillin	Levofloxacin	Sulfamethoxazole
μGAC	Bohart-Adams	K_{BA} (cm^3/mg min)	0.0406	0.0382	0.0260
		q_m (mg/cm^3)	29.63	43.87	29.10
		R^2	0.9844	0.9926	0.9917
	Thomas	K_T (cm^3/mg min)	0.0406	0.0382	0.0260
		q_0 (mg/g)	62.83	93.02	61.71
		R^2	0.9844	0.9926	0.9917
	Yoon-Nelson	K_{YN} (h^{-1})	0,1217	0.1145	0.0781
		τ (h)	42	62	41
		R^2	0.9844	0.9926	0.9917
	Yan or modified dose-response	α´ (-)	5.08	7.92	3.37
		q_F (mg/g)	58.40	91.41	57.03
		R^2	0.9742	0.9840	0.9775
cPAC	Bohart-Adams	K_{BA} (cm^3/mg min)	0.0258	0.0458	0.0345
		q_m (mg/cm^3)	60.22	93.94	84.09
		R^2	0.9854	0.9663	0.9883
	Thomas	K_T (cm^3/mg min)	0.0258	0.0458	0.0345
		q_0 (mg/g)	127.70	199.20	178.31
		R^2	0.9854	0.9663	0.9883
	Yoon-Nelson	K_{YN} (h^{-1})	0.0775	0.1373	0.1036
		τ (h)	85	133	119
		R^2	0.9854	0.9663	0.9883
	Yan or modified dose-response	α´ (-)	8.15	21.13	11.90
		q_F (mg/g)	126.70	189.12	173.58
		R^2	0.9826	0.9816	0.9980

Table S6. Modelling breakthrough curves of fixed bed adsorbers packed with cPAC using as influent wastewater with 50 mg/L antibiotic concentrations.

Model	Model parameter	Wastewater				Deionized water
		AMX	LVX	SMX	Total Ant	Total Ant
Bohart-Adams	K_{BA} (cm^3/mg min)	0.0362	0.031	0.0262	0.0083	0.0077
	q_m (mg/cm^3)	76.55	88.07	63.61	230.50	232.84
	R^2	0.9874	0.9757	0.9839	0.9791	0.9807
Thomas	K_T (cm^3/mg min)	0.0362	0.031	0.0262	0.0083	0.0077
	q_0 (mg/g)	162.33	186.75	134.90	488.85	493.75
	R^2	0.9874	0.9757	0.9839	0.9791	0.9807
Yoon-Nelson	K_{YN} (h^{-1})	0.1086	0.0942	0.0786	0.0750	0.0694
	τ (h)	108	124	89	109	110
	R^2	0.9874	0.9757	0.9839	0.9791	0.9807
Yan or modified dose-response	α' (-)	11.27	9.94	8.76	7.86	6.94
	q_F (mg/g)	157.84	184.98	134.79	472.88	481.75
	R^2	0.9677	0.9619	0.9767	0.9818	0.9621

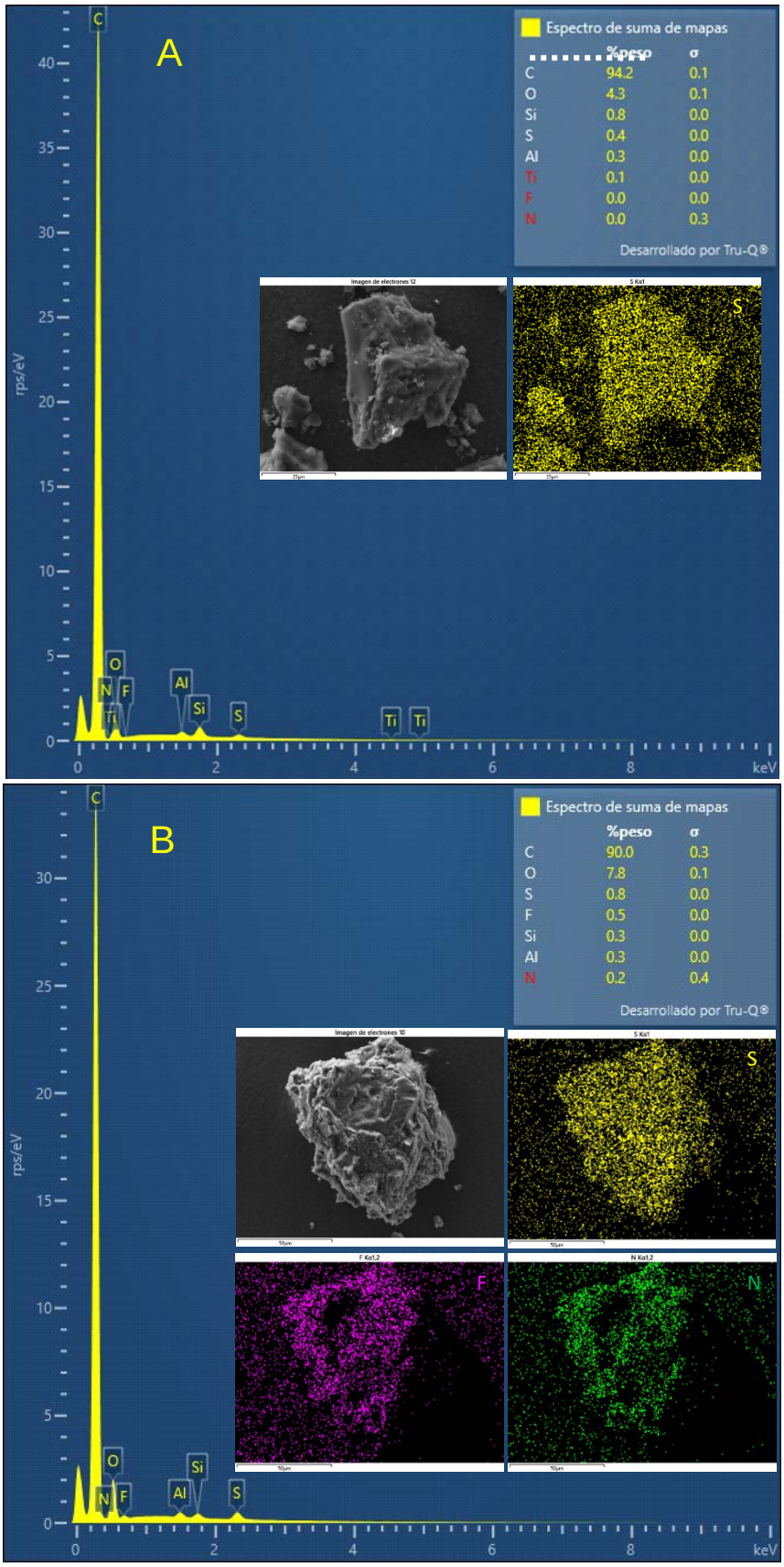


Figure S11. Elemental analyses of a PAC particle determined by energy dispersive X-ray spectroscopy, before (A) and after (B) amoxicillin, levofloxacin, and sulfamethoxazole full adsorption.