Removal of Various Hazardous Materials Using a Multifunctional Biomass-Derived Hydroxyapatite (HAP) Catalyst and Its Antibacterial Effects

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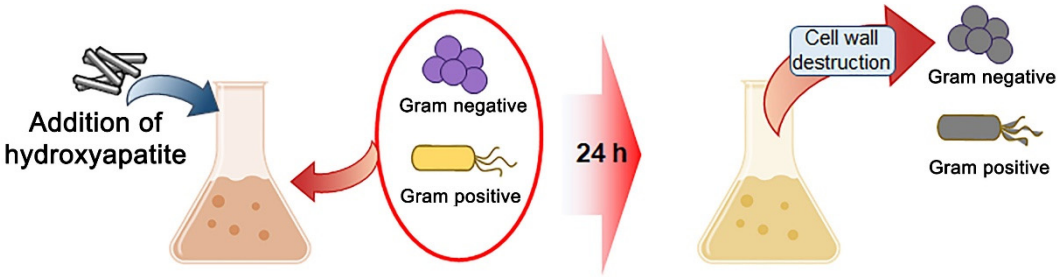

Scheme S1. Schematic image of antibacterial tests using Gram negative and Gram positive, respectively.

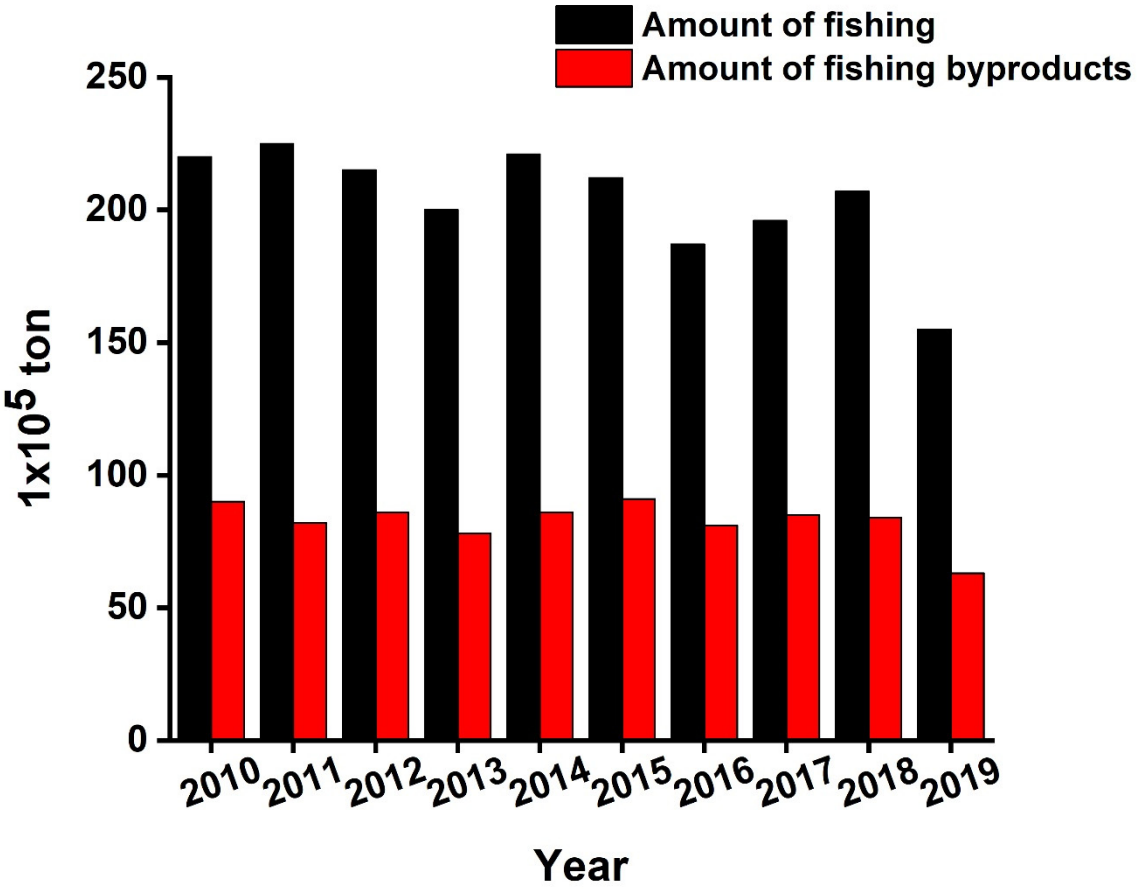

Figure S1. Histogram of South Korean fishery production and byproducts [44].

Figure S2. Oyster shells that have not been treated in South Korea. The photo was taken by Sanha Jang.

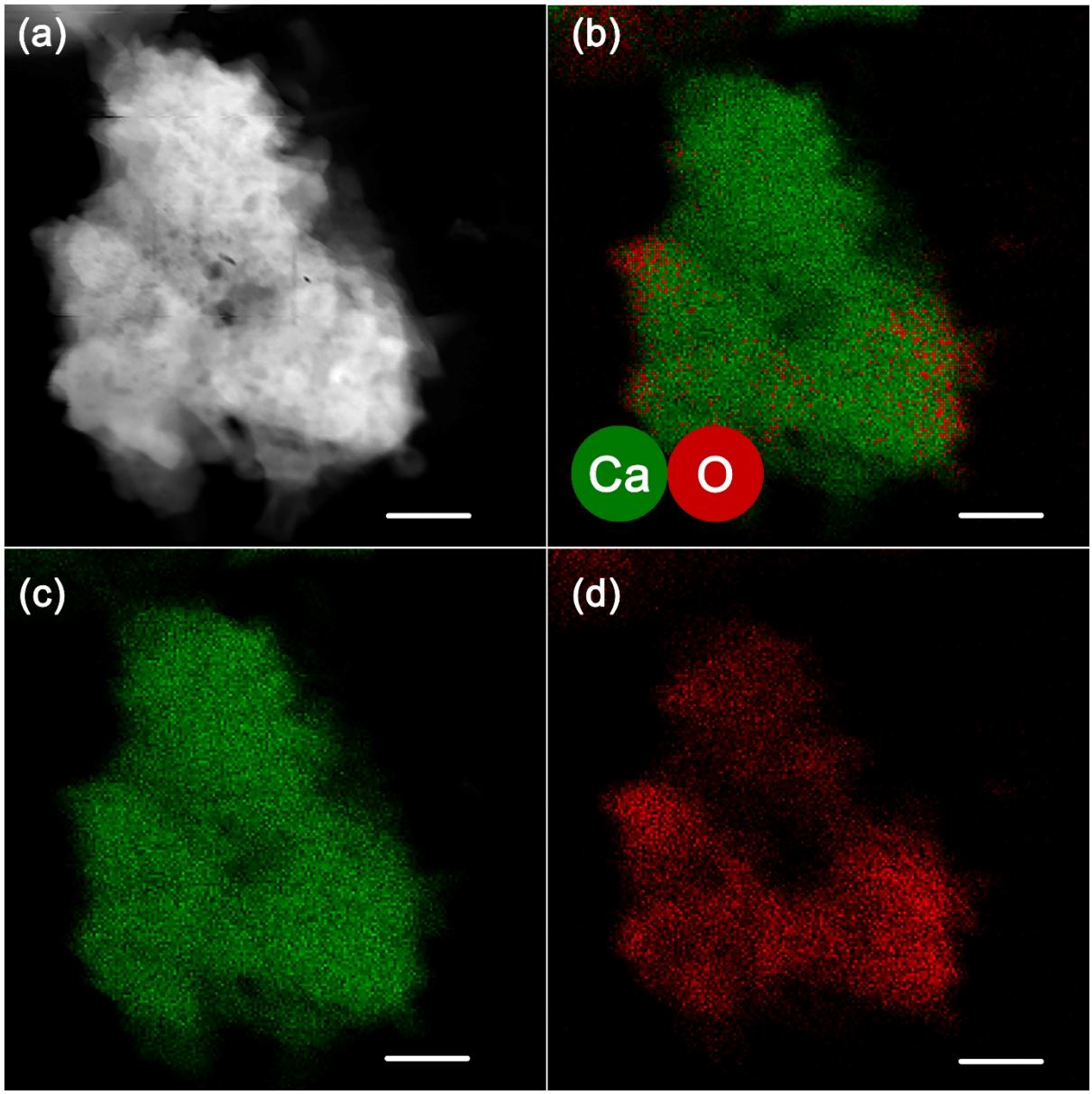

Figure S3. (a) HAADF-STEM image of CaO and (b-d) elemental mapping images of CaO. The bars indicate 100 nm, respectively.

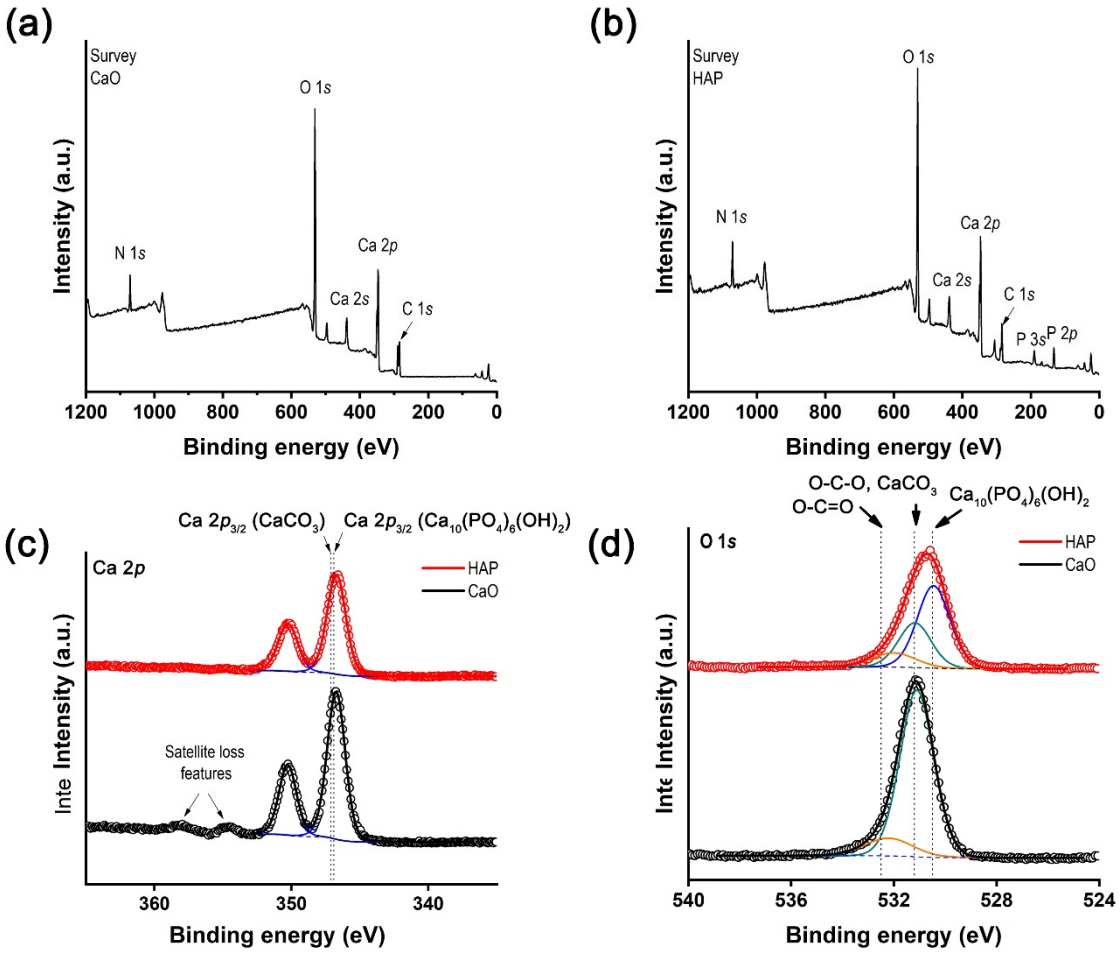

Figure S4. Survey spectrum of (a) CaO and (b) HAP powders and deconvoluted (c) Ca 2*p* and (d) O 1*s* spectrum. The vertical dotted lines indicate the reference binding energy.

Table S1. ICP data table for RT condition of various metal cation adsorption

	Cr	Mn	Ni	Cu	Cd	Ba	Pb
Initial concentration (ppm)	115.39	85.44	98.47	112.60	99.63	114.79	103.52
Final concentration (ppm)	48.56	28.80	61.89	79.78	26.03	64.25	7.49
RSD (%)	0.75	1.90	0.54	0.38	0.95	1.02	5.30
Removal efficiency (%)	57.9	66.3	37.1	29.1	73.9	44.0	92.8

Table S2. ICP data table for various acidic condition of various metal cation adsorption

	Cr			Cd			Pb		
	pH7	**pH5**	**pH4**	**pH7**	**pH5**	**pH4**	**pH7**	**pH5**	**pH4**
Final concentration (ppm)	0.33	64.26	63.63	0	84.08	35.74	13.68	4.52	7.91
RSD (%)	2.12	0.80	2.28	0.65	2.65	0.73	3.97	1.30	1.87
Average removal efficiency (%)	63.0			59.9			91.6		

Table S3. Calculation of antibacterial efficiency of E. coli and S. aureus for 24 h

	Antibacterial efficiency (%)	
Concentration of HAP	***E. coli***	***S. aureus***
5 mM	74.4	78.1
10 mM	89.6	96.0