Supplementary Material

Degradation and detection of organophosphorus pesticides based on peptides and MXene-peptide composite materials

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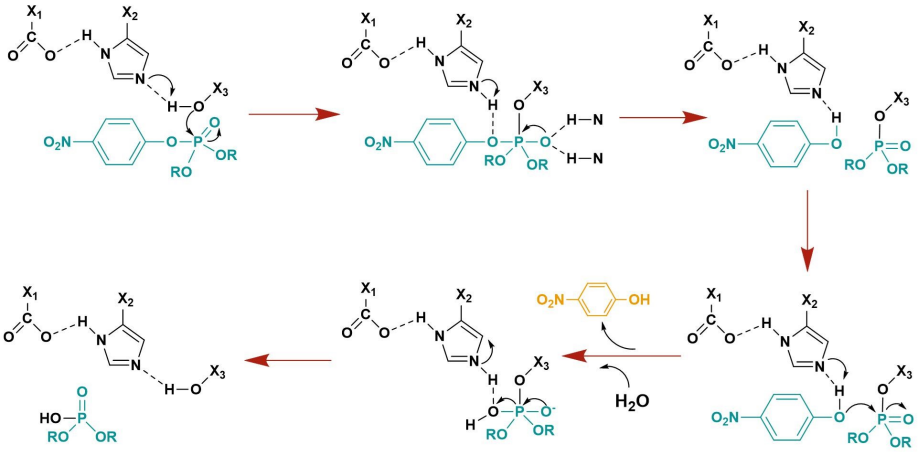

Scheme S1 Mechanism of OPs hydrolysis catalyzed by enzyme. X_1, X_2, and X_3 represent acids, bases, and nucleophiles, respectively.

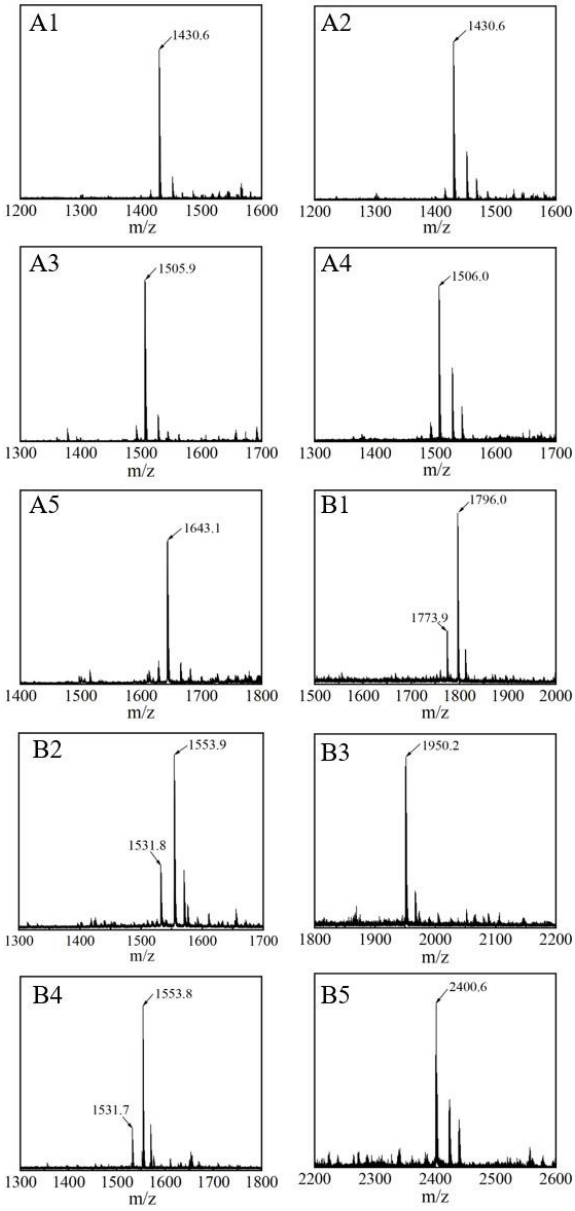

Fig. S1 Mass spectrum of peptides.

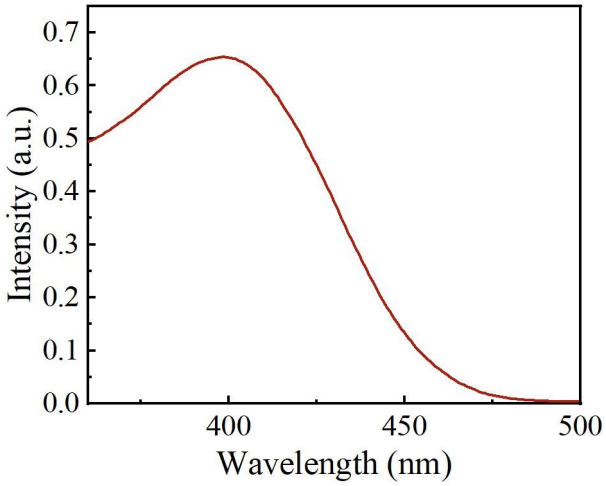

Fig. S2 UV−vis absorbance spectra of PNP ([PNP] = 0.1 mM).

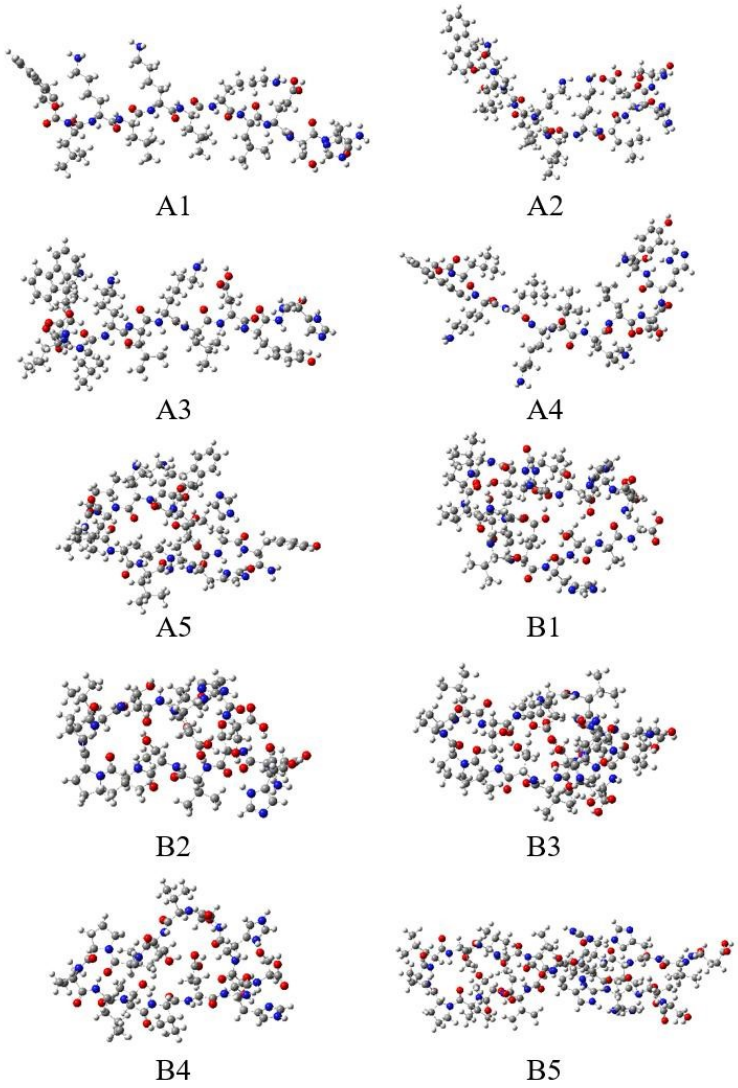

Fig. S3 Geometric configuration of peptides (carbon atoms: gray; nitrogen atoms: blue; oxygen atoms: red; hydrogen atoms: white).

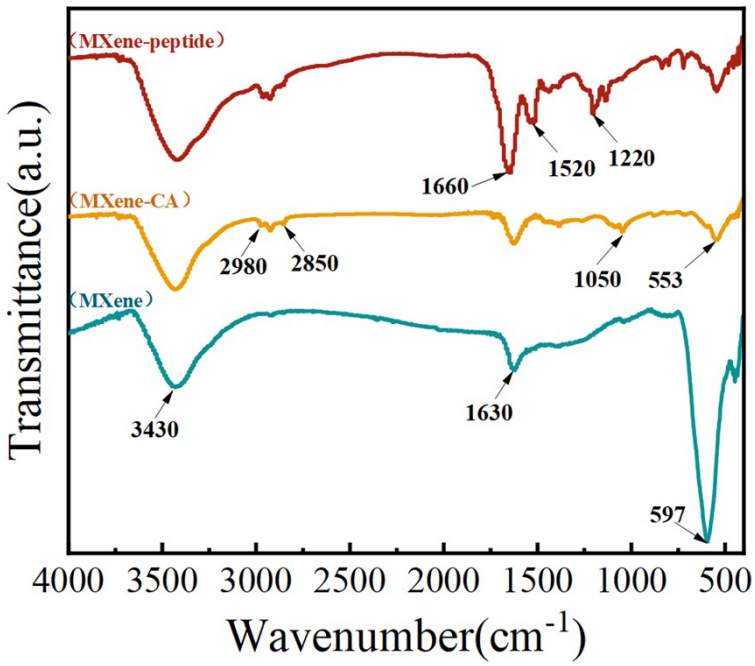

Fig. S4. The ATR-FTIR spectra of MXene, MXene-CA and MXene-peptide.

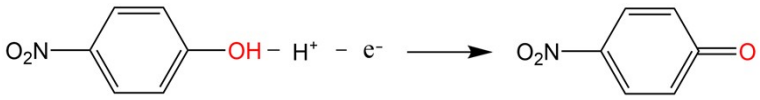

Fig. S5 The oxidation of PNP.

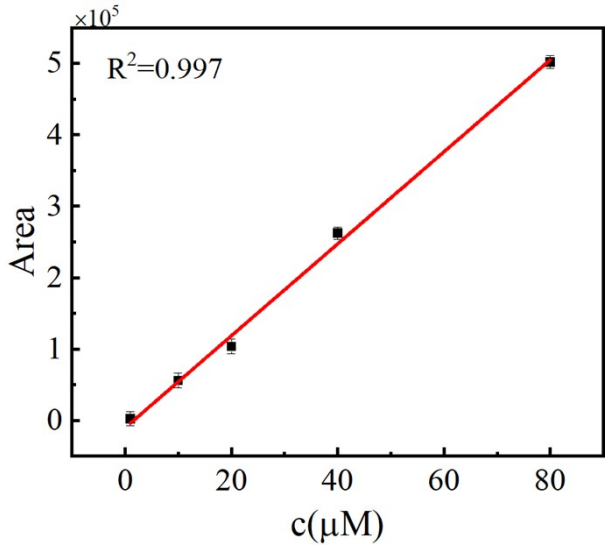

Fig. S6 The standard curve of gas chromatography-mass spectrometry of OPs.

Table S1 Compared to other detection methods

Determinative method	LOD	Linear range	RSD	Detection time
MXene-peptide electrochemical detection (this work)	0.15 μM	1-100 μM	4.71%	15 min
Roll-to-Roll manufactured sensors[1]	1 μM	1-20 μM	<10%	10 min
Fluorescent peptide probes[2]	0.6 μM	1-100 μM	<2%	15 min
Colourimetric sensing platform[3]	0.39 μM	0.5-50 μM	-	2 min
Electrochemical detection based on amino acids[4]	0.24 μM	0.5-100 μM	2.3%	15 min
Multi-enzyme/CNT biosensor[5]	0.50 μM	0.5-40 μM	3.6%	>15 min

Table S2 Analysis of OPs in real samples.

Sample	**OPs**	**Additive amount (μM)**	**Initial value**	**GC-MS**			**Electrochemical analysis**		
				Average value (μM)	Recovery(%)	RSD (%, n=3)	Average value (μM)	Recovery(%)	RSD (%, n=3)
Oilseed rape	methyl paraoxon	5.00	0	4.47	85.59	3.66	4.10	82.00	4.71
		20.00	0	17.68	87.58	3.45	17.66	88.30	4.43
		40.00	0	32.34	77.72	4.09	35.64	89.10	4.30
Bok-choy	methyl paraoxon	5.00	0	4.08	74.65	4.32	3.84	76.80	4.15
		20.00	0	17.28	85.41	3.93	16.87	84.35	3.54
		40.00	0	32.51	78.17	4.21	35.38	88.45	2.95

References

1. A. M. Ulloa, N. Glassmaker, M. R. Oduncu, P. Xu, A. Wei, M. Cakmak and L. Stanciu, *ACS Applied Materials & Interfaces*, 2021, **13**, 35961-35971.
2. J. Wang, J. Zhang, J. Wang, G. Fang, J. Liu and S. Wang, *Journal of Hazardous Materials*, 2020, **389**, 122074.
3. C.-L. Yang, L.-H. Yu, Y.-H. Pang and X.-F. Shen, *Analytica Chimica Acta*, 2024, **1286**, 342045.
4. Y. Liu, X. Cao, Z. Liu, L. Sun, G. Fang, J. Liu and S. Wang, *Analyst*, 2021, **145**, 8068-8076.
5. Y. Zhang, M. A. Arugula, M. Wales, J. Wild and A. L. Simonian, *Biosensors and Bioelectronics*, 2015, **67**, 287-295.