Supporting information

Fe–doped polydopamine nanoparticles with peroxidase-mimicking activity for the detection of hypoxanthine related to meat freshness

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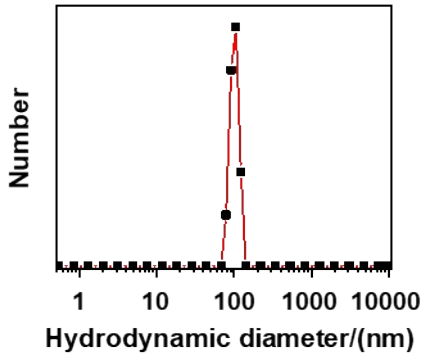

Fig. S1 DLS of Fe-PDA nanoparticles in D.I. water.

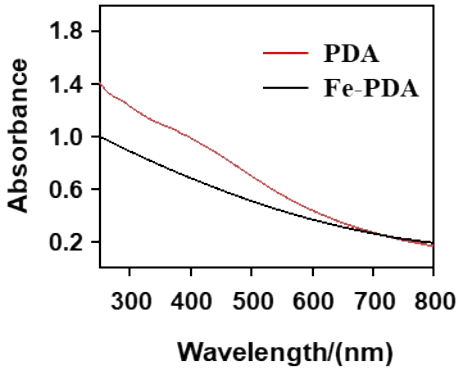

Fig. S2 UV-vis absorption spectra of Fe-PDA and PDA nanoparticles in D.I. water.

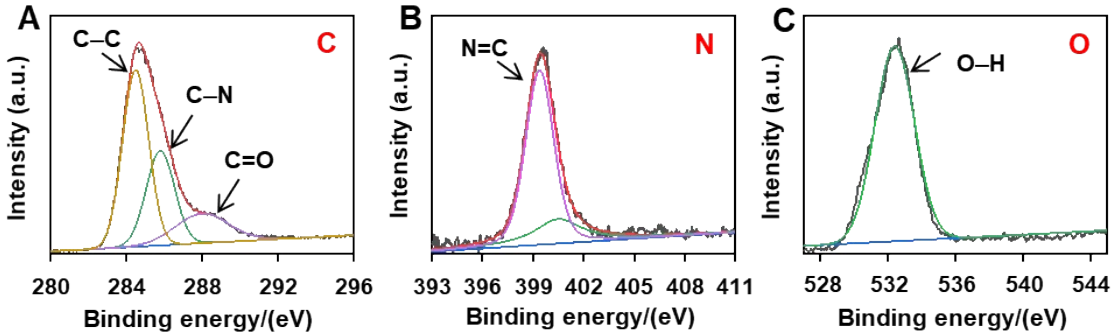

Fig. S3 High-resolution of (A) C 1s, (B) N 1s, and (C) O 1s spectra of PDA nanoparticles, respectively.

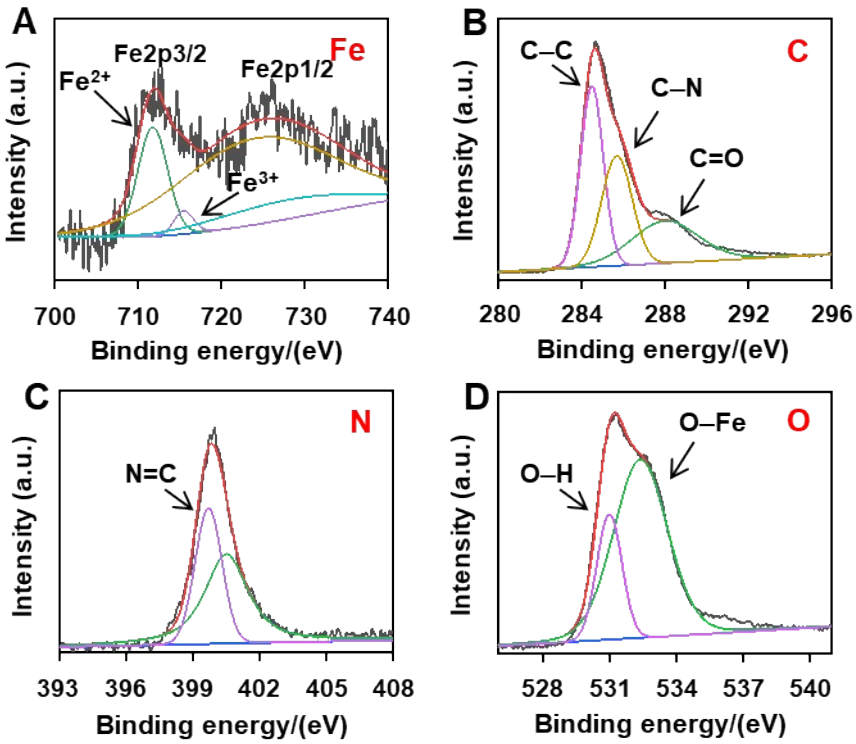

Fig. S4 High-resolution of (A) Fe 2p, (B) C 1s, (C) N 1s, and (D) O 1s spectra of Fe-PDA nanoparticles, respectively.

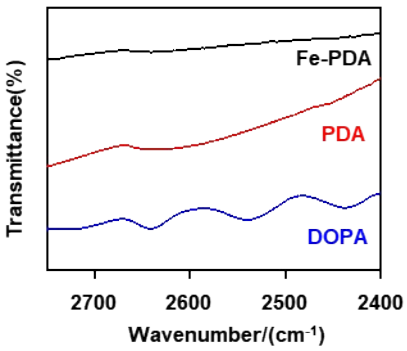

Fig. S5 FT-IR spectra of DOPA, PDA and Fe-PDA.

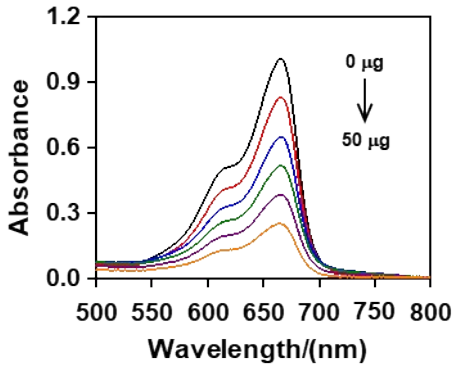

Fig. S6 The absorption spectra of methylene blue (MB) degradation by different concentrations of Fe-PDA nanoparticles. Fe-PDA nanoparticles at 0, 10, 20, 30, 40 and 50 μg·mL^{-1} were incubated with 5 μg·mL^{-1} MB at 37 ℃ for 2 h. After incubation, 200 μM of H_2O_2 was added for 15 min and the absorbance at 500-800 nm was measured using UV spectrophotometer.

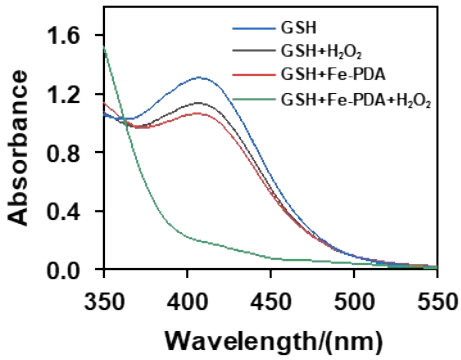

Fig. S7 Absorption spectra of GSH, GSH + H_2O_2, GSH + Fe-PDA, GSH + Fe-PDA + H_2O_2 after incubated with 5,5'-Dithiobis-(2-nitrobenzoic acid) (DTNB). 0.4 mM of GSH was reacted with H_2O_2, Fe-PDA, Fe-PDA + H_2O_2 at 37 ℃ for 1 h, and 0.15 mM of DTNB was added to develop the color and measured the absorbance at 350-550 nm. GSH without anything added was used as a control. Where the concentration of H_2O_2 was 200 μM and Fe-PDA was 50 μg·mL^{-1}.

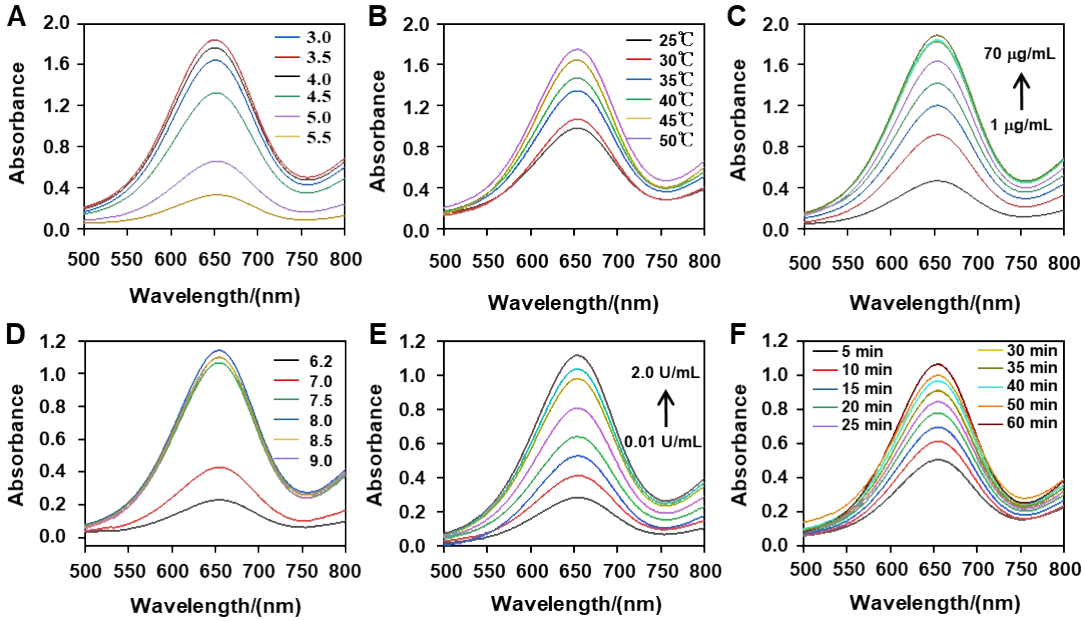

Fig. S8 UV-vis absorption spectra of (A) pH value of Fe-PDA nanoenzyme, (B) incubation temperature, (C) the concentration of Fe-PDA nanoenzyme, (D) pH value of XOD, (E) XOD concentration, (F) incubation time of Hx reacting with XOD for the responding to Hx based on this Fe-PDA nanoenzyme sensing system. All experiments under the following conditions: H_2O_2, 100.0 μM; TMB, 1.0 mM; Fe-PDA nanoparticles, 50.0 μg·mL^{-1}, an optimized XOD concentration, 1.0 U·mL^{-1}; incubation time of Hx reacting with XOD, 40.0 min; XOD catalyzes Hx solution pH 3.5.

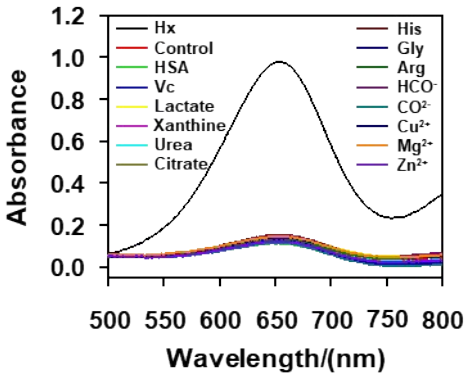

Fig. S9 UV-vis absorption spectra for selectivity tests of the proposed Fe-PDA nanoenzyme-based sensing system for Hx. the concentrations of Hx was 200.0 μM and each of the interferences were 500.0 μM. The reaction were measured at 1.0 mM of TMB, 50.0 μg·mL^{-1} of Fe-PDA nanoparticles in NaAc-HAc buffer solution (5.0 mM). All experiments were incubated in 45.0 ℃ at pH = 3.5.

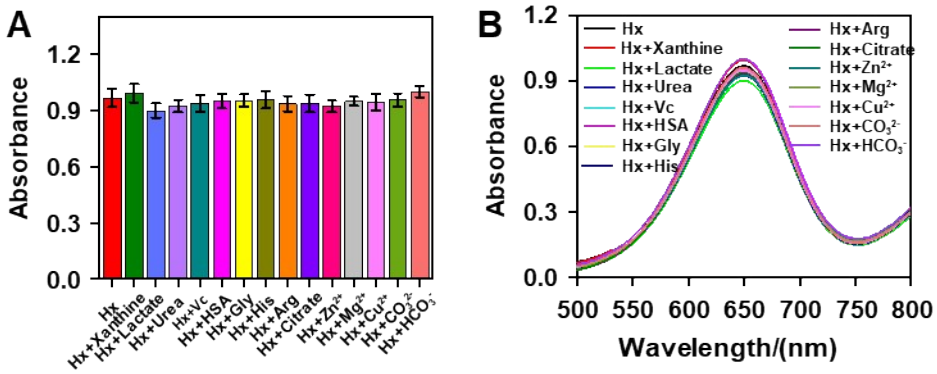

Fig. S10 (A) Anti-interferential tests of the proposed Fe-PDA nanoenzyme-based sensing system for Hx. (B) UV-vis absorption spectra for anti-interferential tests of the proposed Fe-PDA nanoenzyme-based sensing system for Hx. the concentrations of Hx was 200.0 μM and each of the interferences were 200.0 μM. The reaction were measured at 1.0 mM of TMB, 50.0 $\mu g \cdot mL^{-1}$ of Fe-PDA nanoparticles in NaAc-HAc buffer solution (5.0 mM). All experiments were incubated in 45.0 ℃ at pH = 3.5. The error bar was the deviation of the three determinations.

Table S1 Comparative table of steady-state kinetics of different catalytic substrates through TMB oxidation.

Enzyme mimics	**K_m (mM)**		**V_{max} (Ms^{-1})**		***Ref.***
	TMB	H_2O_2	TMB	H_2O_2	
MoS_2	0.525	0.0116	5.16×10^{-8}	4.29×10^{-8}	[1]
AuNPs	0.11	61.34	15.39×10^{-9}	6.63×10^{-9}	[2]
HRP	0.434	3.700	10.00×10^{-8}	8.710×10^{-8}	[3]
AuNPs@C_3N_4	0.097	12.3	1.52×10^{-8}	9.0×10^{-8}	[4]
Fe-PDA	0.4	0.16	20.59×10^{-8}	21.49×10^{-8}	This work

Table S2 Analytical characteristics of miscellaneous Hx biosensors.

Detectors	Linear range/(μM)	Detection limit/(μM)	*Ref.*
Co-doped-g-C_3N_4	7.34-450	5.40	[3]
Graphene/titanium dioxide nanocomposite	20-512	9.5	[5]
TPE-HPro/XO	5-120	1.20	[6]
Glassy carbon paste electrode	20-80	5.3	[7]
Ferrocene carboxylic acid modified electrode	5-20	4.5	[8]
NH_2-Cu-MOF nanosheet	10-2000	3.93	[9]
Pholasin	0.5-10	–	[10]
gold nanoparticles-single-walled carbon nanohorn	1.5-35.4	0.61	[11]
Fe-PDA nanoparticle	5.13-200	1.54	This work

References

1 T. Lin, L. Zhong, L. Guo, F. Fu and G. Chen, *Nanoscale*, 2014, **6**, 11856-11862.

2 Q. Xue, X. Niu, P. Liu, M. Wang, Y. Peng, H. Peng and X. Li, *Sensor. Actuat. B Chem.*, 2021, **334**, 129650.

3 X. Wang, Z.-Z. Lin, C.-Y. Hong and Z.-Y. Huang, *New J. Chem.*, 2021, **45**, 18307-18314.

4 N. Wu, Y.-T. Wang, X.-Y. Wang, F.-N. Guo, H. Wen, T. Yang and J.-H. Wang, *Analyt. Chim. Acta*, 2019, **1091**, 69-75.

5 J. A. V. Albelda, A. Uzunoglu, G. N. C. Santos and L. A. Stanciu, *Biosens. Bioelectron.*, 2017, **89**, 518-524.

6 Z. Zhang, R. T. K. Kwok, Y. Yu, B. Z. Tang and K. M. Ng, *J. Mater. Chem. B*, 2018, **6**, 4575-4578.

7 Ü. A. Kirgöz, S. Timur, J. Wang and A. Telefoncu, *Electrochem. Commun.*, 2004, **6**, 913-916.

8 A. T. Lawal and S. B. Adeloju, *Food Chem.*, 2012, **135**, 2982-2987.

9 S. Hu, J. Yan, X. Huang, L. Guo, Z. Lin, F. Luo, B. Qiu, K.-Y. Wong and G. Chen, *Sensor. Actuat. B Chem.*, 2018, **267**, 312-319.

10 D. E. Farthing, D. Sica, M. Hindle, L. Edinboro, L. Xi, T. W. B. Gehr, L. Gehr, C. A. Farthing, T. L. Larus, I. Fakhry and H. T. Karnes, *Luminescence*, 2011, **26**, 65-75.

11 L. Zhang, J. Lei, J. Zhang, L. Ding and H. Ju, *Analyst*, 2012, **137**, 3126-3131.