Electronic supplementary information

A portable turbidity-based sensor constructed via inhibition of lipase activity for point-of-use testing of dichlorvos pesticide

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1. Supplementary experimental section

1.1. Reagents and materials

CaLB was purchased from Novozymes Biotechnology Co., Ltd. (5000 U/g, Beijing, China). Tween-20 was obtained from Sinopharm Group (Shanghai, China). DDVP was purchased from Shenzhen Bolinda Technology Co., Ltd. (Shenzhen, China). Other standard substances of pesticides including demeton, profenofos, parathion-methyl, glyphosate, acephate, pyrethroid pesticide (PYR) including fenvalerate, neonicotinoid pesticides (NCTPs) including imidacloprid and dinotefuran, and organochlorine pesticide (OCP) including heptachlor, dichlorodiphenyltrichloroethane (DDT) and hexachlorocyclohexane (HCH) were purchased from Dr. Ehrenstorfer (Augsburg, Germany). Calcium chloride ($CaCl_2$) was bought from Xilong Chemical Co., Ltd. (Guangdong, China). The aqueous solutions were prepared by the use of ultrapure water (18.2 MΩ cm) from Milli-Q system (Millipore, USA). All reagents used in this study were of analytical grade, and all solutions were prepared as aqueous solutions unless otherwise specified. A commercial kit for DDVP detection was supplied by Shandong Yuntang Intelligent Technology Co., Ltd. (Shandong, China). Baby cabbage, cherry tomatoes, and coriander were purchased from a local supermarket (Changsha, China). Fresh tea leaves were harvested from our university's tea garden (Changsha, China).

1.2. Detection of DDVP in real samples

Actual food samples, including baby cabbage, coriander, cherry tomatoes, and fresh tea leaves, were analyzed. Sample pretreatment was conducted in accordance with

the guidelines specified in GB/T 5009.199-2003, a recommended standard method for the rapid detection of OPs in China. Typically, the samples were initially wiped to remove the soil on their surface. The cabbage samples, coriander leaves, and tea leaves were cut into small pieces of about 1 cm^2, and cherry tomatoes were directly selected. Then, a portion of the sample (5.0 g) was placed into an extraction bottle containing 5 mL of PBS buffer (pH 8.0, 1 mM) and shaken for approximately 2 min. The extracted solution was subsequently filtered using a 0.22 μm filter before testing.

1.3. Detection of DDVP by a commercial kit

The detection of DDVP using a commercial kit was conducted as follows. The test kit comprises an enzyme solution (AChE), a chromogenic agent solution (5, 5′-dithiobis-(2-nitrobenzoic acid)), a substrate solution (ATCh), and an extraction solution for the pesticide. In brief, 500 μL of either DDVP standard or sample solutions was combined with 20 μL of the enzyme solution and 20 μL of the chromogenic agent solution in a 1.5 mL centrifuge tube. Following incubation at 37 °C for 15 min, 20 μL of the substrate solution was added and mixed thoroughly. After allowing the reaction to proceed for 3 min, absorbance was recorded at a wavelength of 412 nm. All measurements were done in triplicate.

2. Additional figures

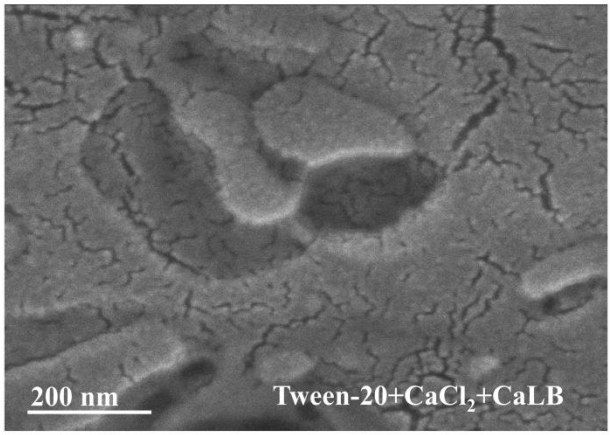

Fig. S1. SEM image of the precipitate of Tween-20/$CaCl_2$ + CaLB

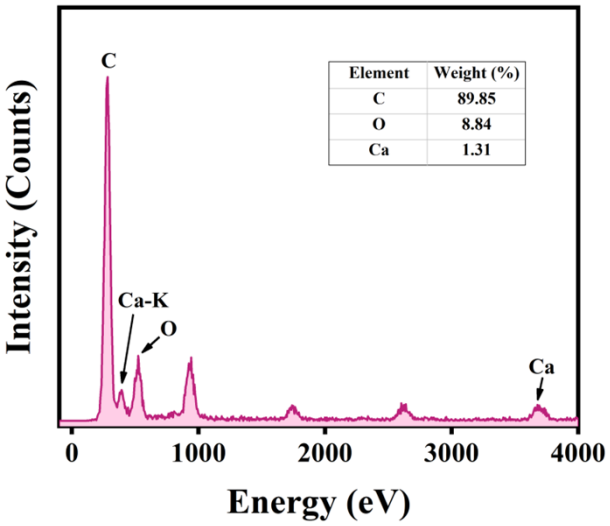

Fig. S2. EDS image of the precipitate of Tween-20/$CaCl_2$ + CaLB

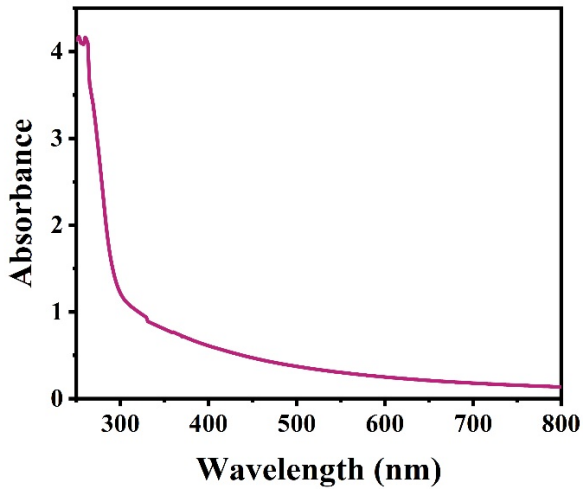

Fig. S3. UV-vis absorption spectrum of Tween-20/$CaCl_2$ + CaLB.

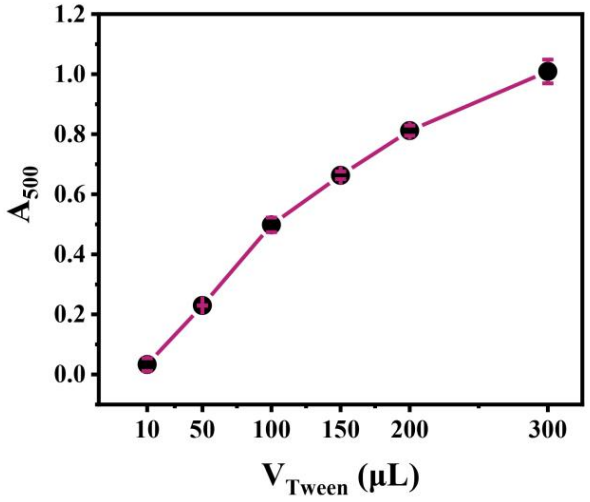

Fig. S4. Optimization of the doge of Tween-20. Absorbance of Tween-20/$CaCl_2$ + CaLB against the doge of Tween-20.

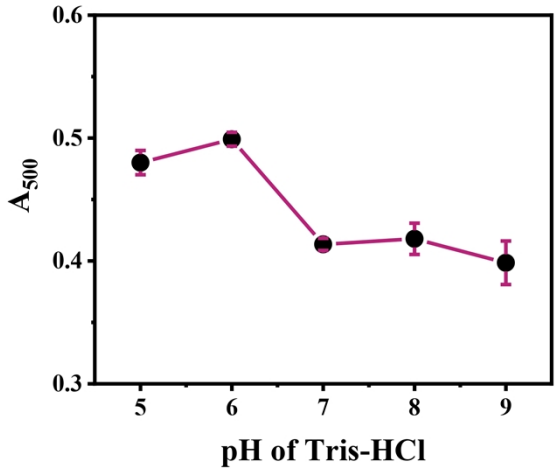

Fig. S5. Optimization of pH. Absorbance of Tween-20/$CaCl_2$ + CaLB against the change of pH (Tris-HCl, 50 mM).

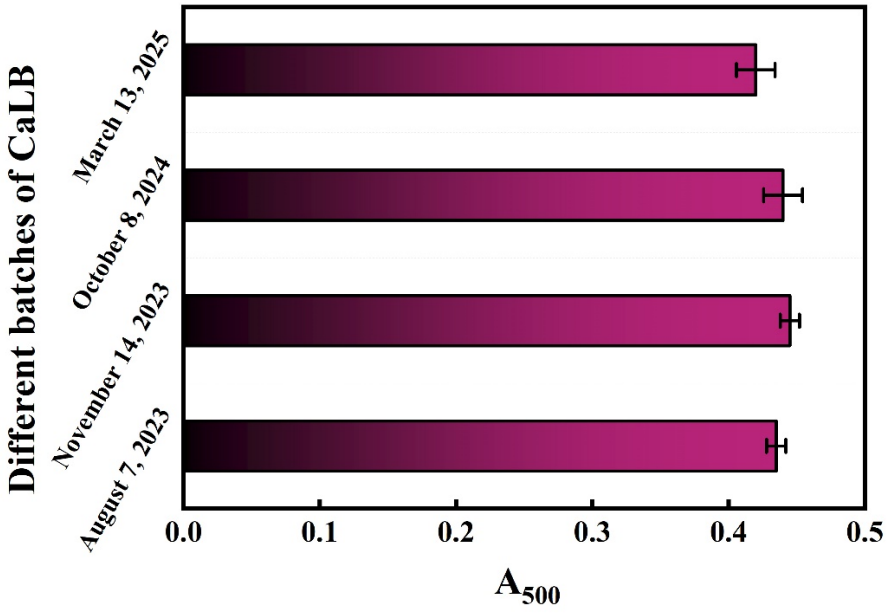

Fig. S6. Comparison of CaLB activity among four different batches.

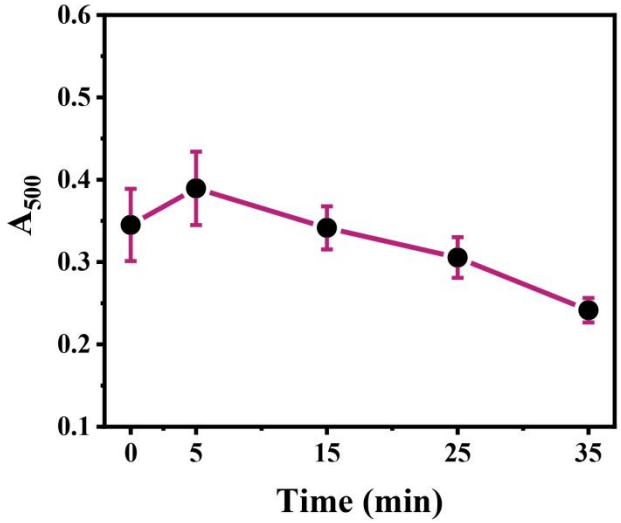

Fig. S7. Optimization of time. Absorbance of Tween-20/$CaCl_2$ + CaLB against the change of time.

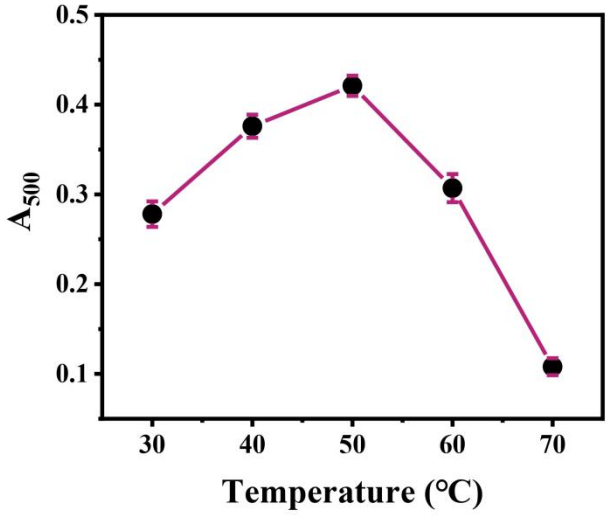

Fig. S8. Optimization of temperature. Absorbance of Tween-20/$CaCl_2$ + CaLB against the change of temperature.

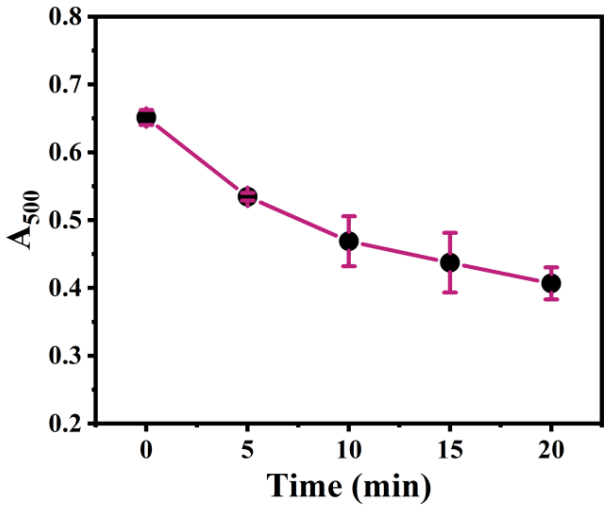

Fig. S9. Optimization of inactivation time of CaLB. Absorbance against different inactivation times of CaLB enzyme.

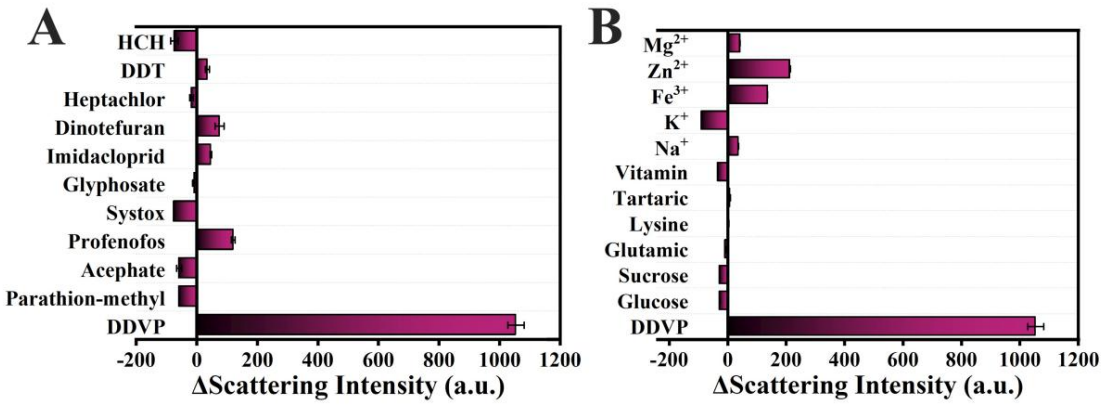

Fig. S10. Scattering response of the sensing system to different pesticides (A) and different ions and organic compounds (B), respectively. Concentration: all pesticides, 1 μg mL^{-1}; ions and organic molecules, 10 μg mL^{-1}.

3. Additional tables

Table S1. A comparison between some reported sensors and the proposed sensor for detecting dichlorvos (DDVP) in analytical performance.

Material	Pesticide	Signal	Linear range (μg/mL)	LOD (μg/mL)	Ref.
AuNRs	Dichlorvos	Colorimetric	1×10^{-5}-5×10^{-2}	8.1×10^{-6}	S1
Nitrogen-doped porous carbon/BDD	Dichlorvos	Electrochemistry	1×10^{-7}-1×10^{-2}	1.5×10^{-9}	S2
FeMnOx	Dichlorvos	Colorimetric	0.001-3	2.67×10^{-4}	S3
γ-MnOOH NWs	Dichlorvos	Colorimetric	0-0.015	0.003	S4
Fe_3O_4 NPs	Dichlorvos	Chemiluminescence	1×10^{-3}-0.04	3.8×10^{-4}	S5
CuSNPs	Dichlorvos	Fluorescence	1×10^{-4}-0.1	1×10^{-4}	S6
Chitosan-TiO_2-graphene nanocomposites	Dichlorvos	Electrochemistry	7.9-4950	6.4	S7
CDs-Fe	Dichlorvos	Photothermal	0.005-0.65	4.85×10^{-3}	S8
MnO_2NSs/CQDs	Dichlorvos	Fluorescence	0.004-0.12	1.2×10^{-3}	S9
Commercial reagents	Dichlorvos	Turbidity	0.05-1.5	6.25×10^{-4}	This work

Table S2. Detection of DDVP in real samples by the proposed sensor and a commercial kit-based spectrophotometric method.

Sample	Added (ng/mL)	Proposed sensor			Commercial kit		
		Found (ng/mL)	Recovery (%)	RSD (%)	Found (ng/mL)	Recovery (%)	RSD (%)
Tea	0	n.d. [a]	/	/	n.d.	/	/
	300	358.04	119.35	9.26	339.96	113.32%	4.04%
	850	829.15	97.55	7.51	792.08	93.19%	3.62%
	1000	896.98	89.70	7.71	803.44	80.34%	7.06%
Cherry tomato	0	n.d.	/	/	n.d.	/	/
	300	324.07	108.02	1.28	323.11	107.70%	12.40%
	850	844.84	99.39	1.24	884.54	104.06%	5.28%
	1000	951.87	95.19	1.70	988.53	98.85%	7.35%
Baby cabbage	0	n.d.	/	/	n.d.	/	/
	300	291.29	97.10	3.70	344.80	114.93%	6.83%
	850	955.18	112.37	1.20	905.27	106.50%	2.10%
	1000	835.69	83.57	1.86	959.77	95.98%	5.01%
Coriander	0	n.d.	/	/	n.d.	/	/
	300	331.17	110.39	2.80	339.46	113.15%	6.43%
	850	939.60	110.54	2.27	852.93	100.34%	16.53%
	1000	917.59	91.76	10.49	1018.29	101.83%	6.00%

Note, n.d.[a], not detected.

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