Supplementary Materials for:

Intelligent quantification of Mn(VII) in irrigation water using YOLO v3 artificial intelligence-driven smartphone monitoring platform based on nitrogen-doped blue fluorescence carbon dots

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Materials

L-malic acid, indomethacin, and EDTA disodium were gained from Shanghai Aladdin Reagent Co., Ltd. (Shanghai, China). NH_4Cl, $BaCl_2$, $MnCl_2$, $CaCl_2$, $CrCl_3$, $CoCl_2$, $MgCl_2$, $NiCl_2$, $SnCl_2$, $ZnCl_2$, KI, Na_2S, KF, Na_3PO_4, $Na_2S_2O_3$, KSCN, Na_2SO_4, NaCl, Na_2CO_3, $NaNO_3$, KBr, Na_2SO_3, $NaNO_2$, cysteine, phenylalanine, alanine, methionine, glutathione, arginine, tyrosine, proline, tryptophan, threonine, aspartic acid, asparagine, isoleucine, and glycine were purchased from Beijing Chemical Corp (Beijing, China). Distilled deionized (DDI) water was obtained from a Millipore Milli-Q-RO4 water purification system with a resistivity higher than 18 MΩ cm^{-1} (Bedford, MA, USA). Dialysis membranes with a MWCO of 500-1000 Da were obtained from Beijing Solarbio Science & Technology Co., Ltd. (Beijing, China).

Apparatus

Transmission electron microscopy (TEM) study was performed in a JEOL JEM-2100 (Tokyo, Japan) instrument operating at an accelerating voltage of 200 KV. Atomic force microscope (AFM) images were obtained using an AFM Bruker MultiMode 8 in the contact mode. UV-vis absorption spectra were recorded using a Puxi TU-1901 UV-vis absorption spectrophotometer. Fluorescent (FL) spectra were operated with a F-280 FL spectrophotometer (Tianjin, China). Fourier transform infrared (FTIR) spectra were recorded on Thermo Scientific Nicolet iS50 FTIR Spectrometer (US). X-ray photoelectron spectrometer (XPS) data were obtained with an AXISULTRA DLD electron spectrometer from Shimadzu Company using 300W Al Kα radiation. All FL images were collected with Zeiss LSM880 confocal laser-scanning microscope.

Detection Experiments in irrigation water

The detection ability of the B-CDs for Mn(VII) was evaluated in irrigation water. The irrigation water sample is obtained from Shanxi University that were subjected to recovery experiments. Fristly, Mn(VII) was determined by adding irrigation water containing different concentrations of Mn(VII) (20, 50, 80, 120, 175, and 220 μM) to B-CDs system, respectively. Then, the Mn(VII) concentrations were intelligently quantified through YOLO v3 AI-driven smartphone monitoring platform.

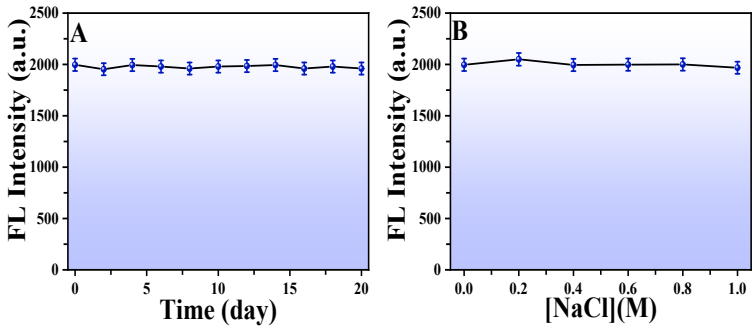

Fig. S1 The effects of storage time (A) and NaCl concentration (B) on FL intensity of B-CDs.

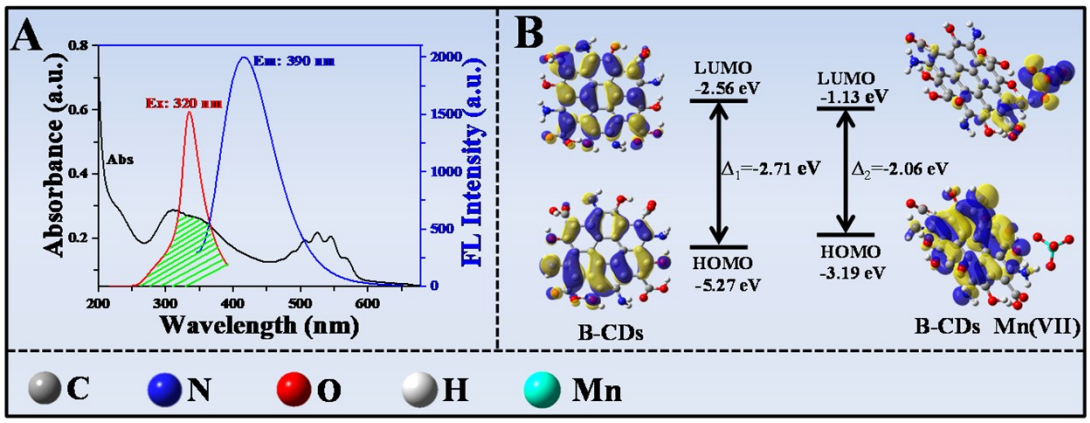

Fig. S2 (A) The overlap between absorption spectrum of Mn(VII) and the excitation-emission spectra of B-CDs. (B) Energy gap diagrams of HOMO and LUMO of B-CDs and before and after introducing Mn(VII).

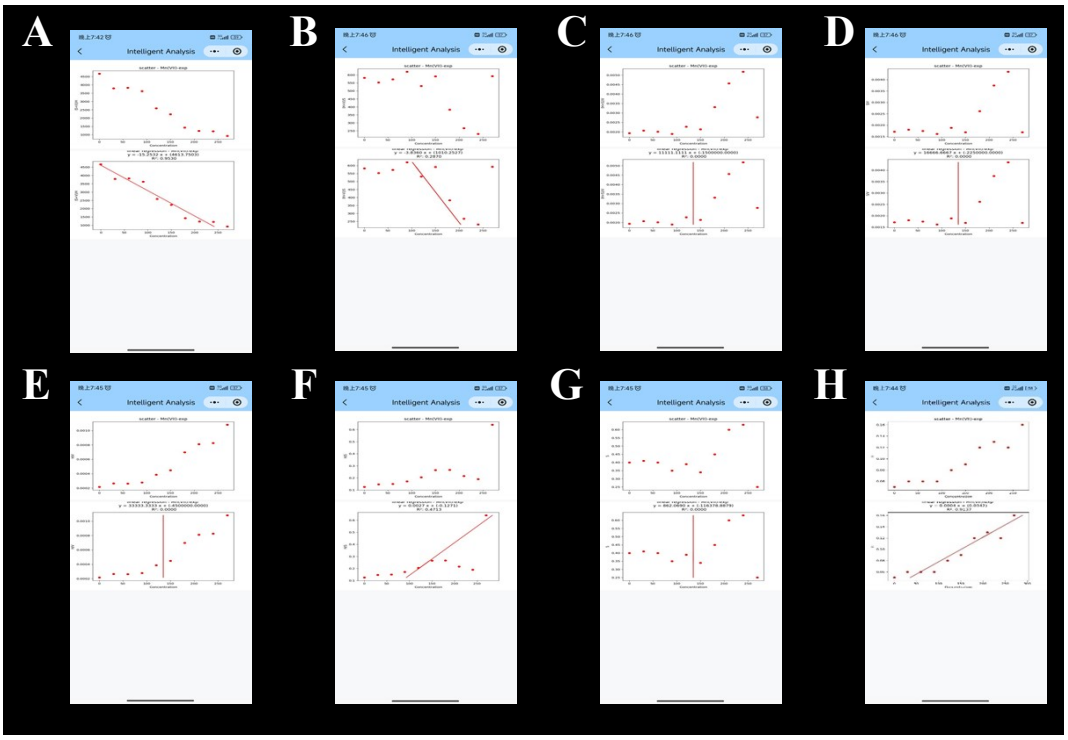

Fig. S3 Standard curves of Mn(VII) concentration fitted with different colour parameters based on Bayesian Ridge algorithm (Colour parameters: H, S, V, H/S, H/V, S/V, (H+S)/V, (H+V)/S, and (S+V)/H).

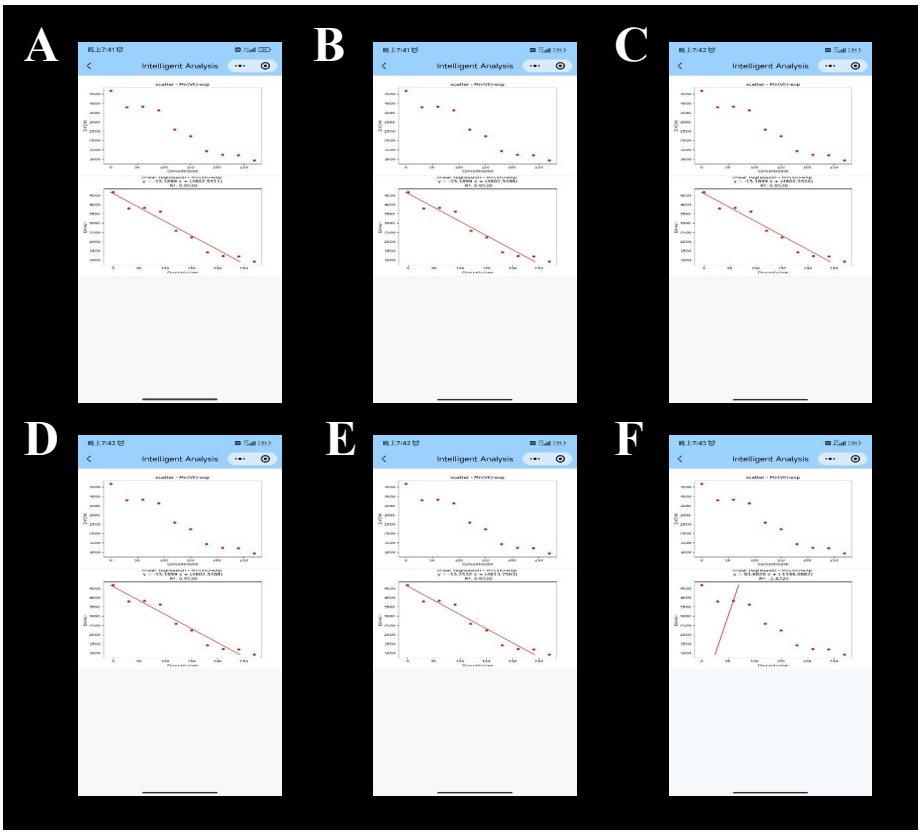

Fig. S4 Standard curves of Mn(VII) concentration fitted with different linear fitting algorithm based on (S+V)/H (Linear fitting algorithm: Least Squares, Ridge, Lasso, Lasso Lars, Bayesian Ridge, and SVM).

Table S1 Comparison of different FL probes for Mn(VII) detection.

Fluorescence probes	Precursor	Linear range (μM)	LOD (nM)	Ref.
N-CDs	Threonine and guanidine hydrochloride	5–35	660	1
N-CDs	Citric acid, p-hydroxybenzoic acid and ammonia	0.51–2	170	2
N,S,P-CQDs	Saccharomyces cerevisiae	0.05–20	50	3
N,P- CDs	Phthalic acid, 1,2-ethylenediamine, and concentrated phosphoric acid	10−200	48.3	4
N,Al-CDs	Durian shell waste, urea, and aluminum nitrate	0–100	46.8	5
CDs	1,2-ethylenediamine, glucose and sulfuric acid	0.05−110	12.8	6
B-CDs	L-malic acid, indomethacin and EDTA disodium	1−270	7.5 nM	This work

Table S2 Performance evaluation of the YOLO v3 algorithm.

Algorithmic model	Precision(%)	Recall(%)	F1-score(%)
YOLO v3	96.5	98.2	97.3

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