Electronic Supplementary Material (ESI) for RSC Advances.

Enhancing catalytic efficiency of carbon dots by modulating their Mn doping and chemical structure with metal salts

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1. Analysis of crystal structure of the obtained Mn doped carbon dots (Mn&N-CDs)\

The X-ray diffraction (XRD) pattern of Mn&N-CDs was obtained using a MiniFlex benchtop X-ray diffractometer (Rigaku, Japan).

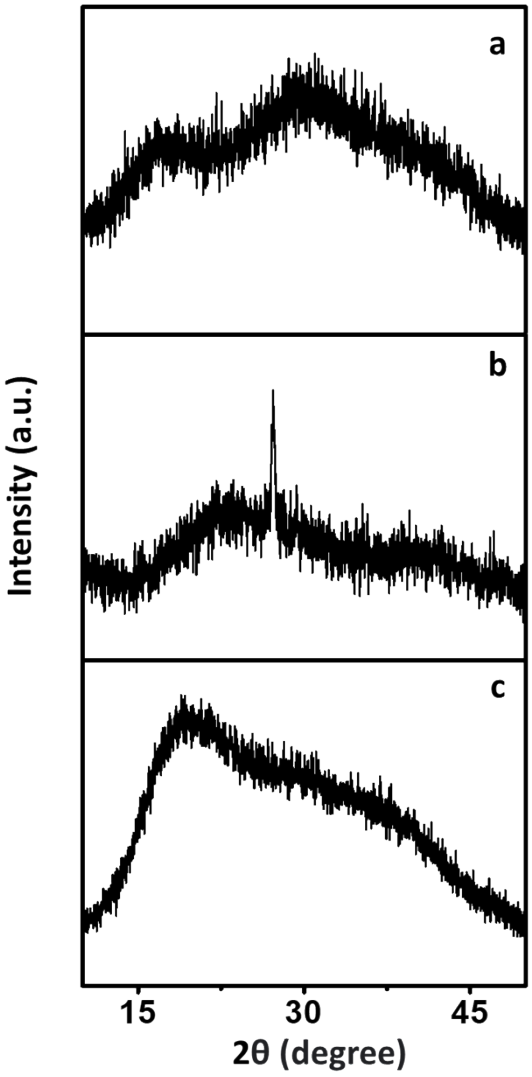

Figure S1. XRD spectrum of Mn&N-CDs; (a). Mn&N-CD_Cl, (b). Mn&N-CD_SO_4, and (c). Mn&N-CD_NO_3.

2. Comparison of infrared (IR) spectra of N-CD and Mn&N-CDs

The Fourier transform infrared spectra of N-CD and Mn&N-CDs were obtained using a Nicolet 6700 (ThermoFisher Scientific, Waltham, United States).

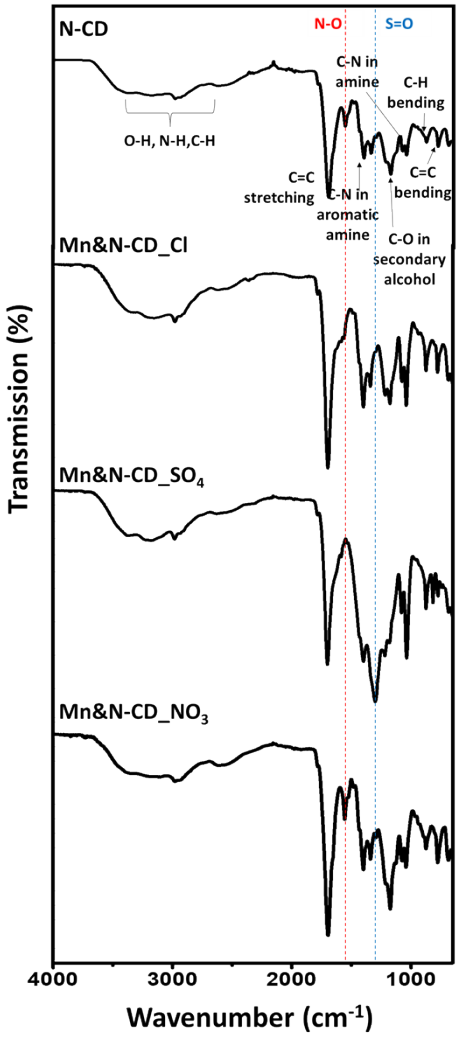

Figure S2. Comparison of IR spectra of N-CD and Mn&N-CDs.

3. Comparison of relative atomic compositions of N-CD and Mn&N-CDs using X-ray photoelectron spectrometry (XPS)

The chemical compositions of N-CD and Mn&N-CDs were investigated through XPS (K-Alpha+, ThermoFisher Scientific, USA). The relative contents of each atom were quantified by measuring the peak area in the survey scan spectra and high-resolution spectra of each atom shown in Figure 2.

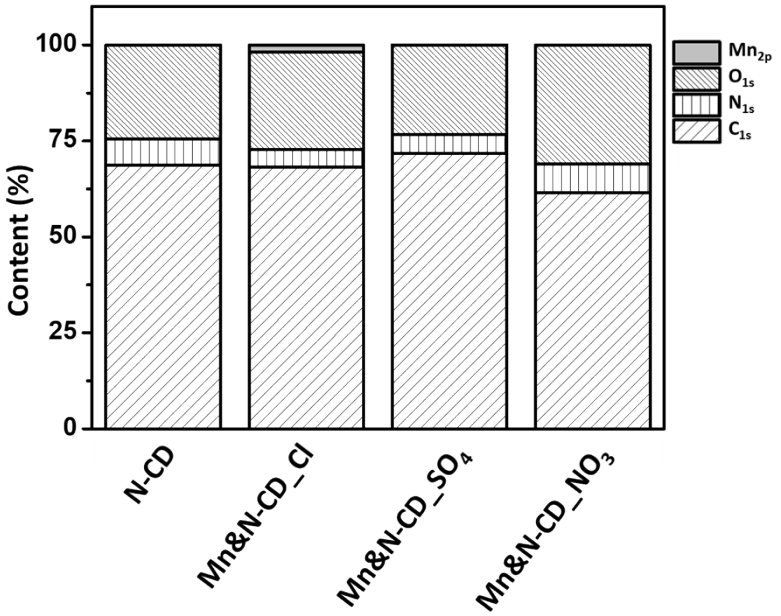

Figure S3. Ratios of each component in N-CD and Mn&N-CDs, which are based on XPS peak area.

4. Analysis of the content of Mn ions in Mn&N-CDs using inductively coupled plasma-mass spectrometry (ICP-MS)

The amounts of Mn ions in three batches of Mn&N-CDs were analyzed using ICP-MS (NEXION-350X, PerkinElmer, USA).

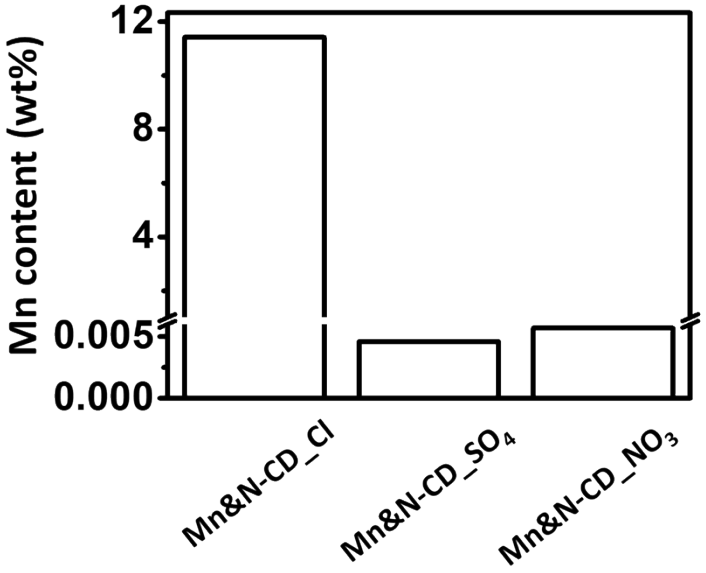

Figure S4. Mn contents in **Mn&N-CD**s.

5. Evaluation of the synergistic catalytic effect of Mn&N-CD_Cl

The enzymatic activity of Mn&N-CD_Cl has been compared to N-CD and $MnCl_2$ mixture at pH 2. Mn&N-CD_Cl showed high enzymatic activity while N-CD and $MnCl_2$ mixture exhibited no recognizable color change.

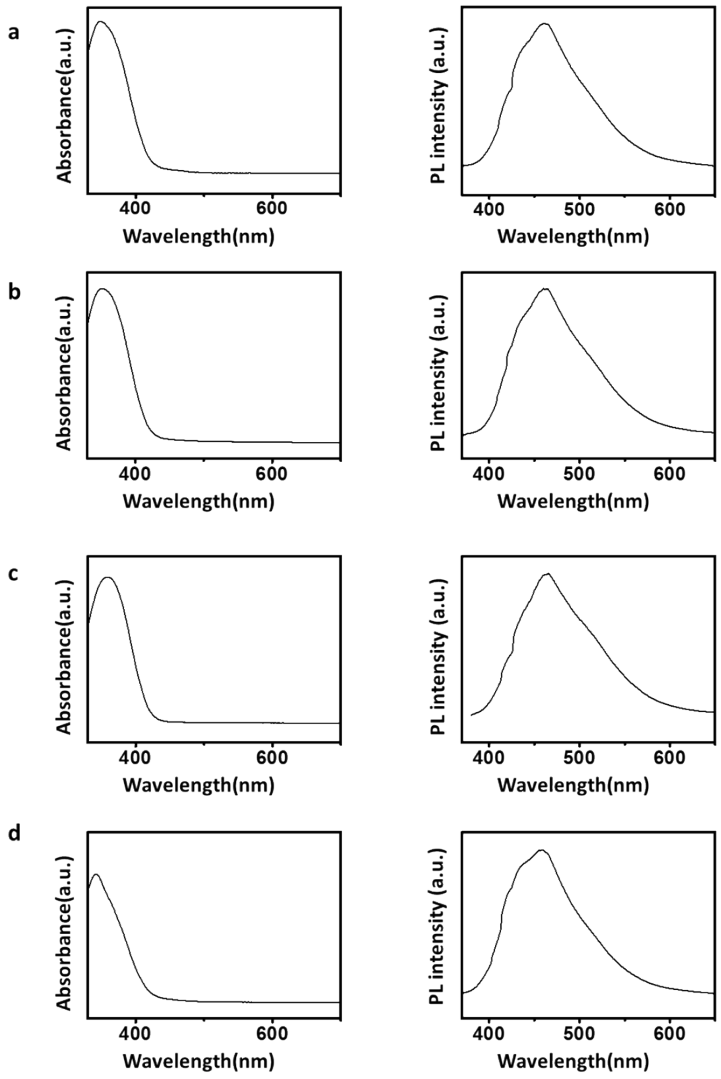

Figure S5. Absorption and emission spectra of (a) N-CD, (b) Mn&N-CD_Cl, (c) Mn&N-CD_SO_4, and (d) Mn&N-CD_NO_3 samples.

6. Photostability of Mn&N-CDs

The photostability of the Mn&N-CD was examined with light exposure. Aqueous suspensions containing Mn&N-CDs were exposed to daylight for 70 h, and their fluorescence intensity at 450 nm (λ_{ex}: 350 nm) was measured using a fluorometer. Then, the enzyme-mimicking activities of Mn&N-CDs were monitored using H_2O_2 and TMB solution.

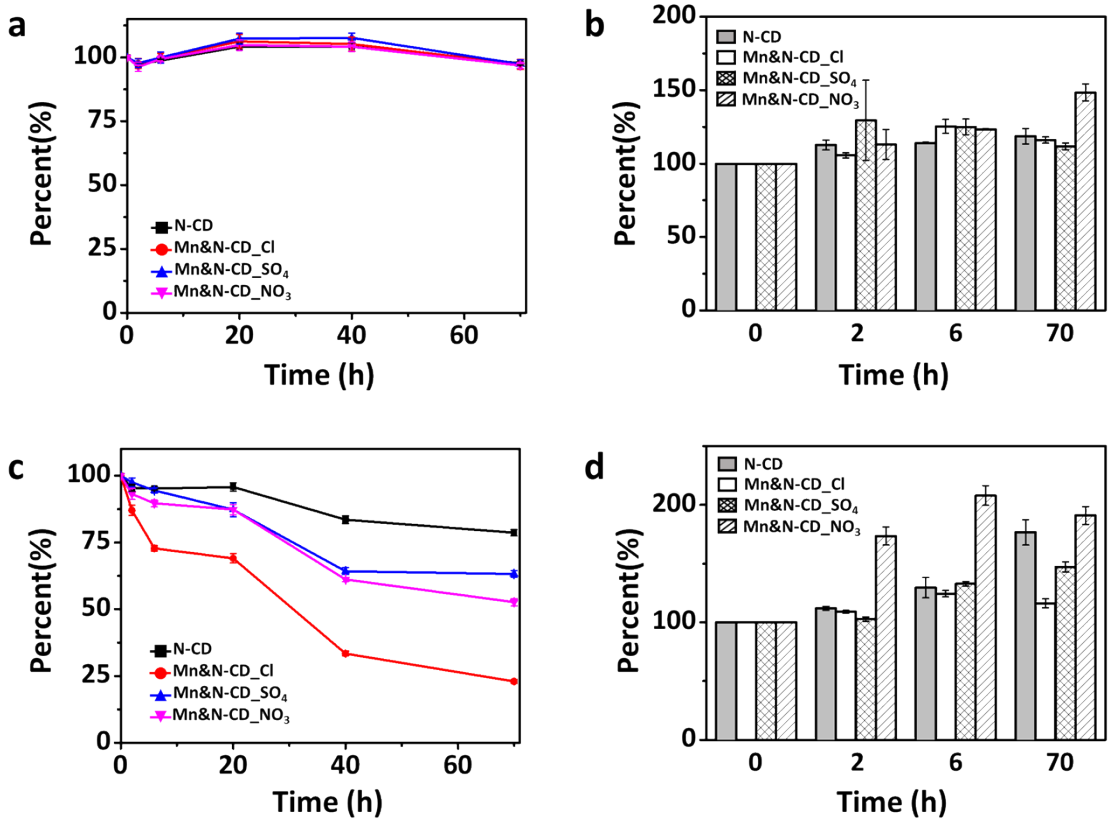

Figure S6. Time-dependent fluorescence intensities (λ_{ex}: 350 nm, λ_{em}: 450 nm; a and c) and catalytic properties (b and d) of N-CDs and Mn&N-CDs which stored in amber (a and b) and transparent (c and d) vials under exposure to daylight.

7. Evaluation of the synergistic catalytic effect of Mn&N-CD_Cl

The enzymatic activity of Mn&N-CD_Cl was compared to that of a mixture of N-CD and $MnCl_2$ at pH 2. To assess the activity levels, the color change of the solutions was monitored after adding N-CD (0.5 mg/ml), N-CD (0.5 mg/ml) and $MnCl_2$ (1.0 mM) mixture, and Mn&N-CD_Cl (0.5 mg/ml) to solutions containing H_2O_2 (100.0 mM) and TMB (10.0 mM). Notably, the solution containing Mn&N-CD_Cl exhibited a strong blue color, indicating high enzymatic activity, whereas the N-CD and $MnCl_2$ mixture showed no recognizable color change like N-CD.

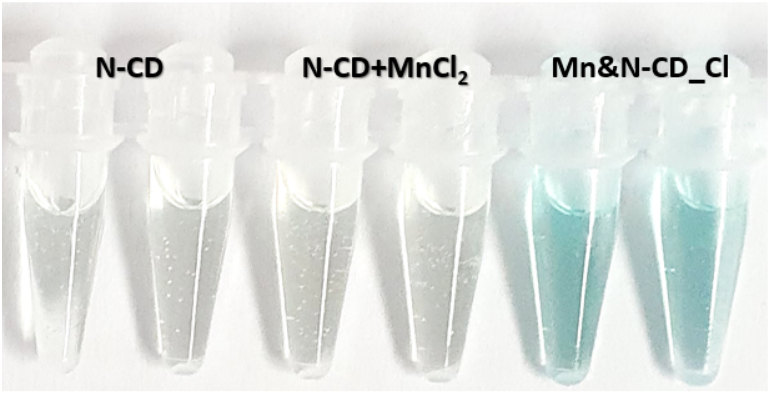

Figure S7. Photograph of solutions containing H_2O_2 and TMB with N-CD, N-CD and$MnCl_2$ mixture, and Mn&N-CD_Cl, respectively.

8. AA detection capability at different Mn source

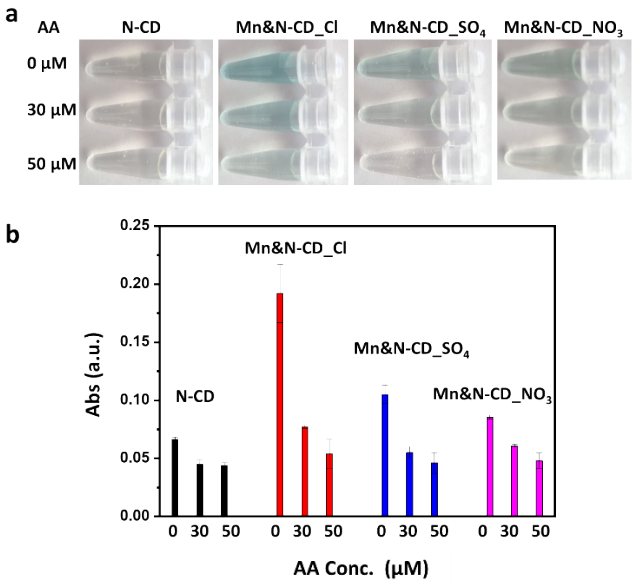

Figure S8. (a) Photograph and (b) absorption intensity of mixture solutions of H_2O_2, TMB, and Mn&N-CDs with AA in different concentrations.