Electronic Supplementary Material

Uric Acid Detection via Dual-Mode Mechanism with Copper-Coordinated with Nitrogen-Doped Carbon dots as Peroxidase Mimics

Mohamed M. El-Wekil[a]*, Yousef A. Bin Jardan[b], Mohamed R. Elmasry[c], Al-Montaser Bellah H. Ali[a]

[a] Department of Pharmaceutical Analytical Chemistry, Faculty of Pharmacy, Assiut University, Assiut, 71526, Egypt

[b] Department of Pharmaceutics, College of Pharmacy, King Saud University, Riyadh, Saudi Arabia

[c] School of Chemical Engineering, Sungkyunkwan University (SKKU), Suwon, 16419, Republic of Korea

*** Correspondence**

mohamed.elwakeel@pharm.aun.edu.eg, **mohamed.mohamoud@ymail.com**

Instrumentation

Fluorescence intensity measurements were carried out using a Shimadzu RF-5301 PC (Tokyo, Japan). UV-Vis absorbance readings were performed with a Shimadzu 1601 PC (Tokyo, Japan). X-ray photoelectron spectroscopy (XPS) spectra were obtained using a Thermo EscalAB 250Xi instrument (Thermo Fisher Scientific, USA). Fourier transform infrared (FT-IR) spectra were recorded with a Nicolet™ iSTM10 spectrograph (Varian Instrument Co., Ltd, USA). Dynamic light scattering (DLS) and zeta potential measurements were conducted using a ZEN 3600 Nano ZS model (Malvern, UK). A transmission electron microscope (TEM, JEOL, JEM-100CX II unit, USA) was used to characterize the Cu@N-CDs. The X-ray diffraction (XRD) patterns of Cu@N-CDs were analyzed using an X-ray diffraction spectrometer PW 1710 (Philips-FEI, Netherlands).

Fluorescence quantum yield measurements of CDs, N-CDs, and Cu@N-CDs (X)

The quantum yield (QY) values were calculated according to the following equation using quinine sulfate (QS) as a reference in 0.1 mol/L H_2SO_4 (QY = 54 %). By measuring the absorbance (less than 0.05) and emission spectra of a certain concentration of X and QS at the same excitation wavelength at 360 nm, the absorbance and fluorescence integral area were substituted into the following formula:

$$\phi_X = \phi_{QS} \times \frac{F_X}{F_{QS}} \times \frac{A_{QS}}{A_X} \times \frac{\eta_X}{\eta_{QS}}$$

Φ_X represents the quantum yield of X, ϕ_{QS} represents the quantum yield of QS, F_X is the fluorescence intensity of X, F_{QS} is the fluorescence intensity of QS, A refers to the absorbance value and η refers to the refractive index of the solvent (distilled water). The synthesized X were dissolved in distilled water (η = 1.33) and QS was dissolved in 0.1 M H_2SO_4 (η = 1.33).

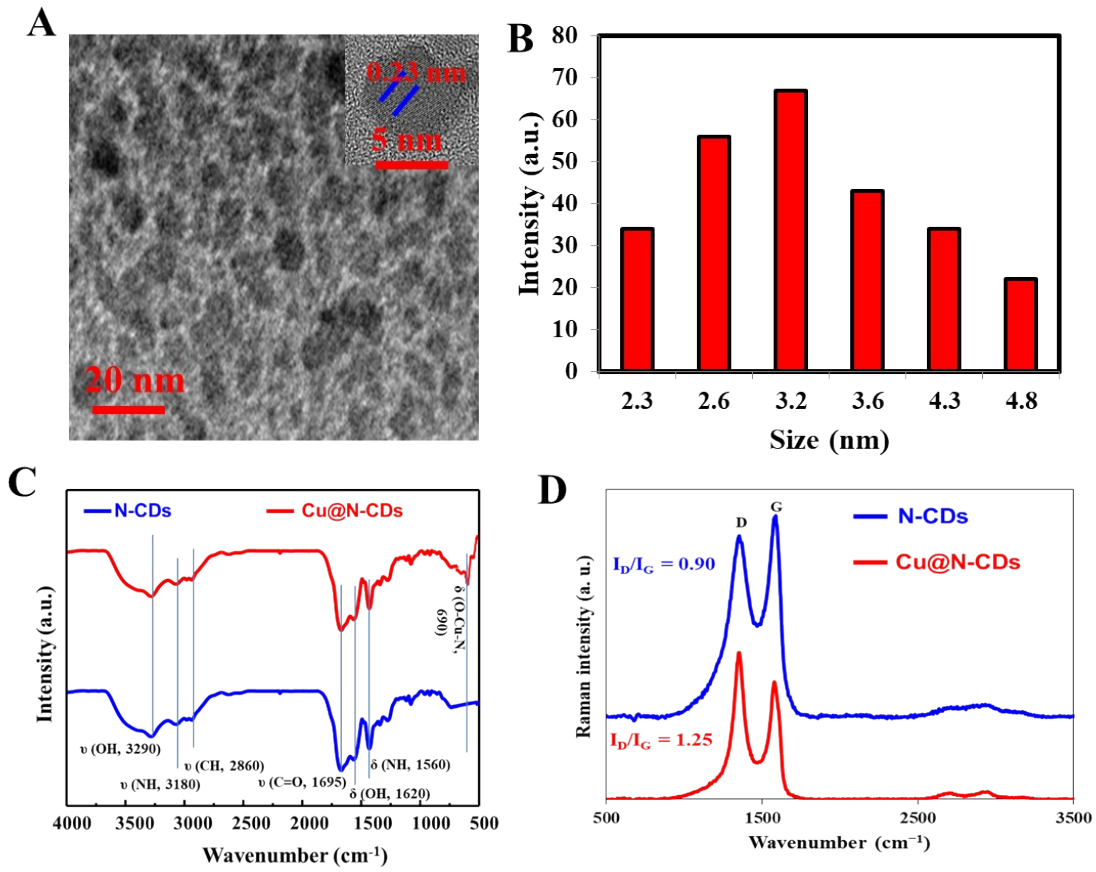

Fig.S1 TEM image (A) and size-distribution diagram (B) of Cu@N-CDs. FT-IR (C) and Raman spectroscopy (D) of N-CDs and Cu@N-CDs.

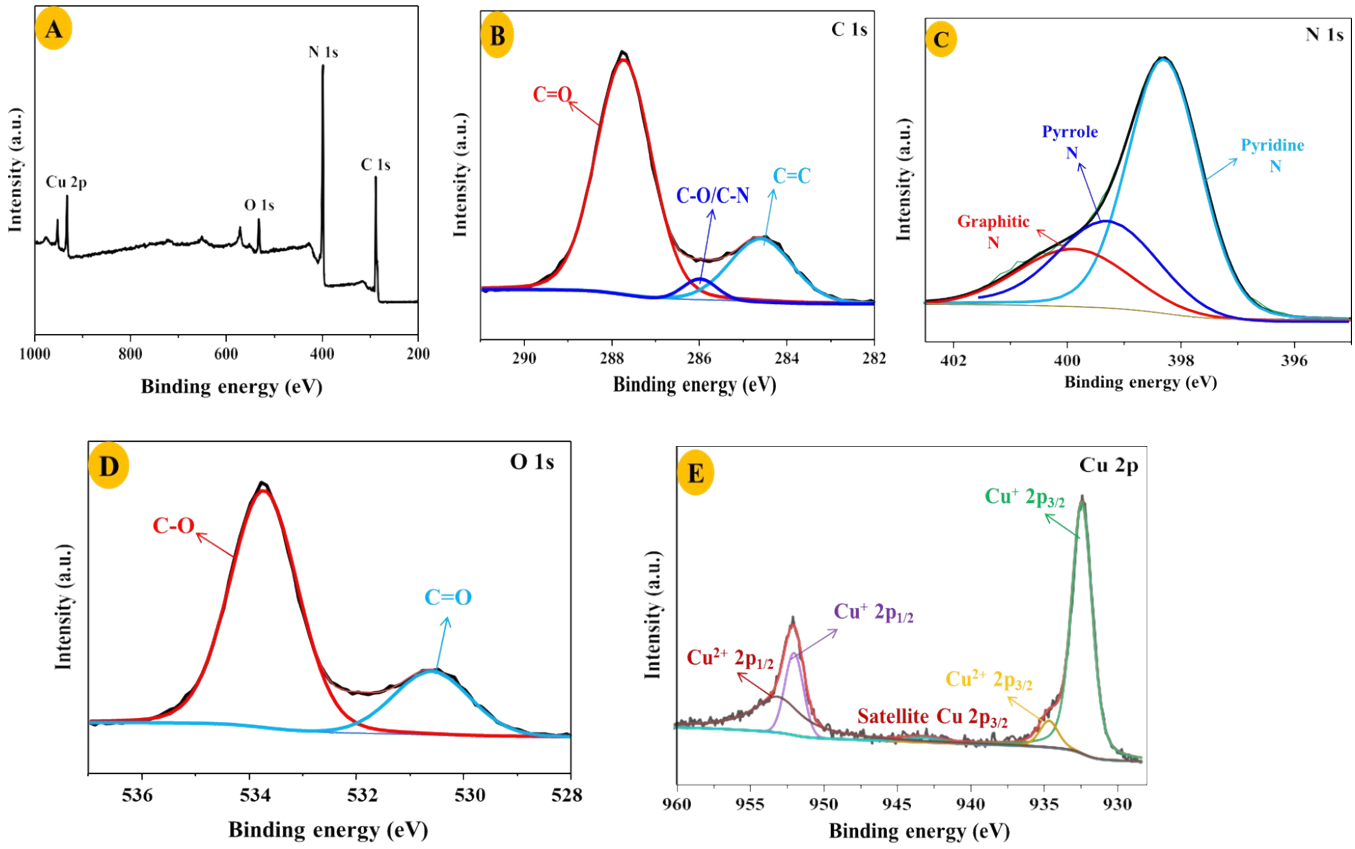

Fig.S2 (A) XPS survey of Cu@N-CDs; (B), (C), (D), and (E) are deconvoluted spectra of C 1s, N 1s, O 1s, and Cu 2P, respectively.

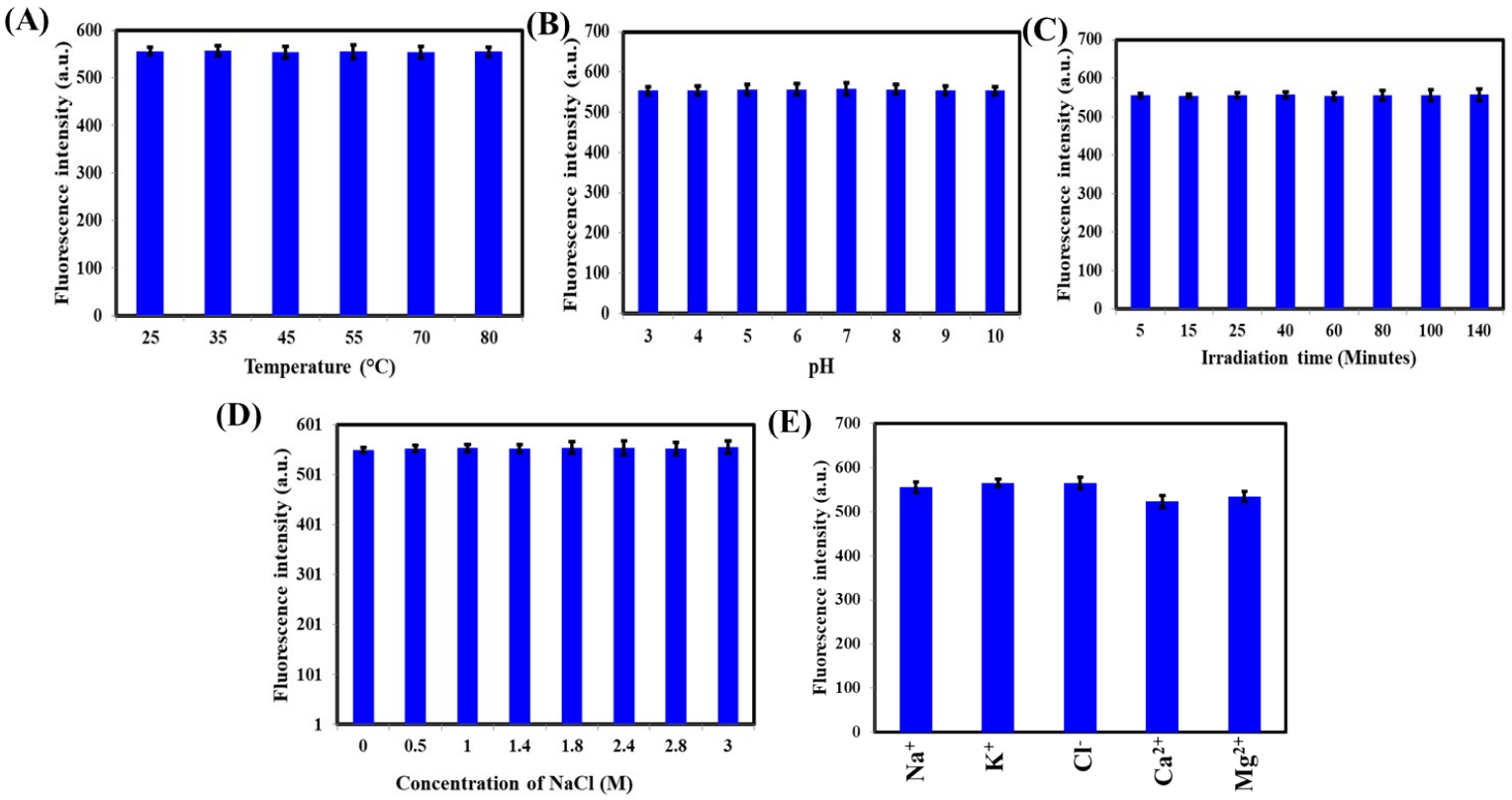

Fig.S3 Stability of the as-prepared Cu@N-CDs under various conditions: effect of (A) temperature, (B) pH value, (C) irradiation time, (D) concentration of NaCl, (E) different ion species (100 mM).

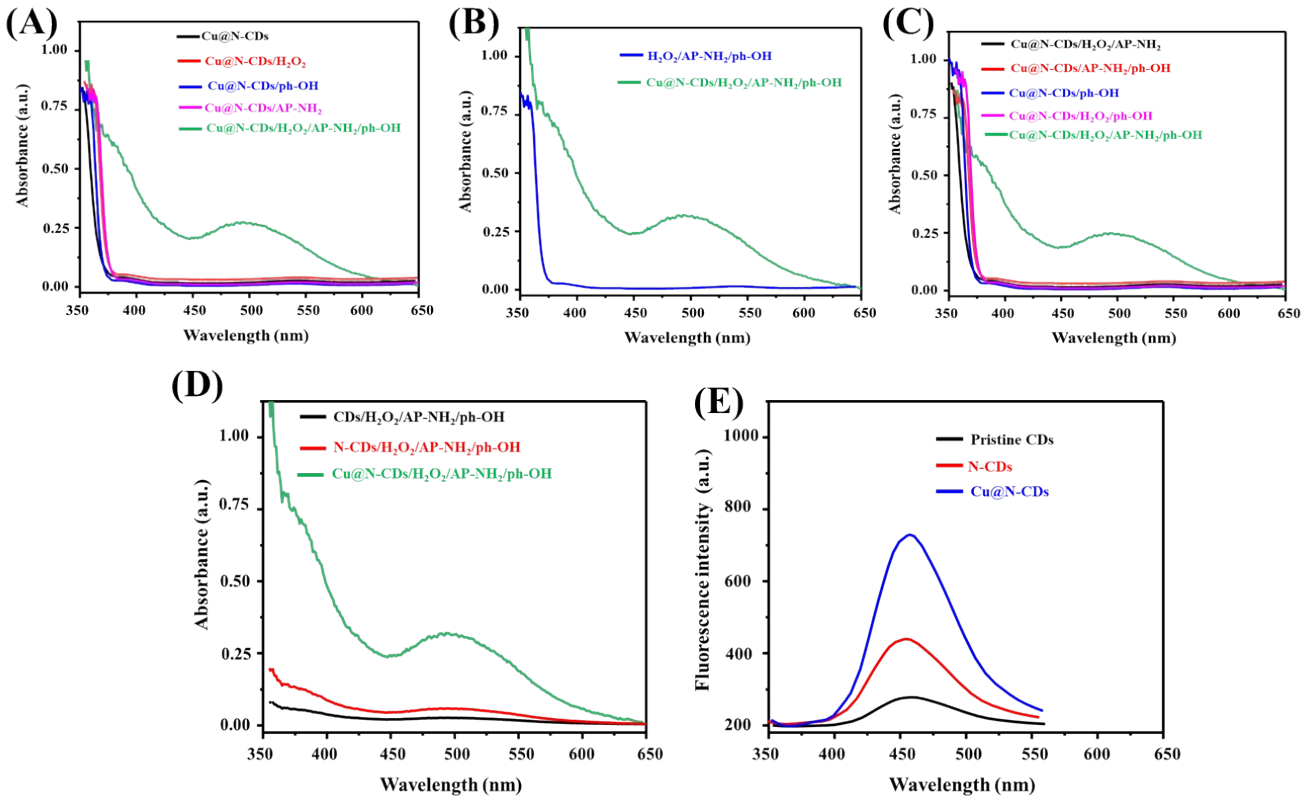

Fig.S4 (a) UV/Vis spectra of Cu@N-CDs, Cu@N-CDs/H_2O_2, Cu@N-CDs /ph-OH, Cu@N-CDs /AP-NH_2, and Cu@N-CDs /H_2O_2/AP-NH_2 /ph-OH, (B) UV/Vis spectra of H_2O_2/AP-NH_2 /ph-OH and Cu@N-CDs /H_2O_2/AP-NH_2/ph-OH, (C) Absorption spectra of Cu@N-CDs /H_2O_2/AP-NH_2, Cu@N-CDs /AP-NH_2/ph-OH, Cu@N-CDs /H_2O_2/ph-OH, and Cu@N-CDs /H_2O_2/AP-NH_2 /ph-OH, (d) Absorption spectra of the AP-NH_2/ H_2O_2/ph-OH in the presence of Cu@N-CDs, N-CDs, and CDs. (e) Fluorescence emission of CDs, N-CDs, and Cu@N-CDs.

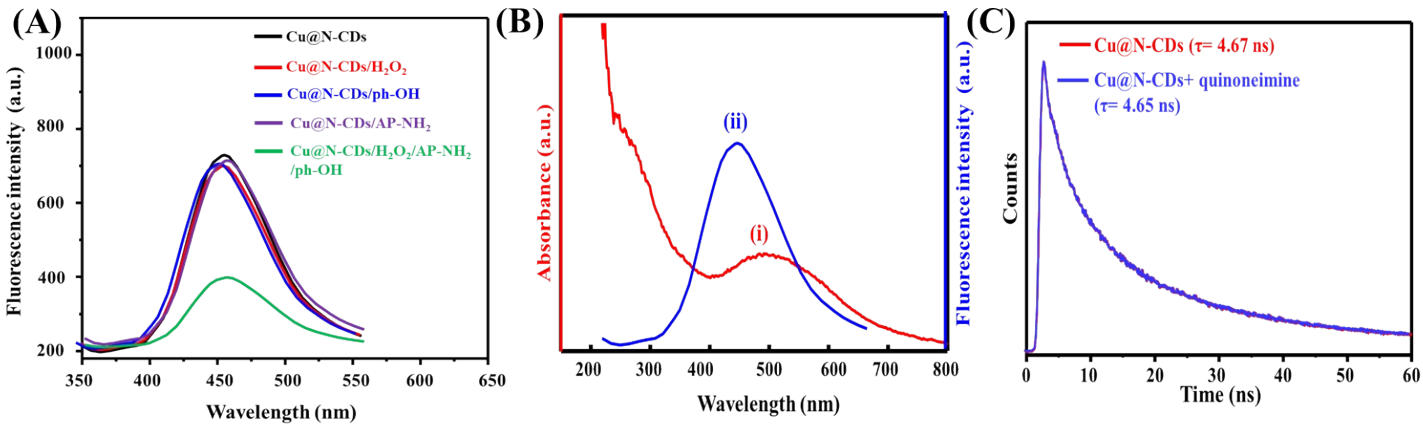

Fig.S5 (A) Fluorescence spectra of Cu@N-CDs, Cu@N-CDs/H_2O_2, Cu@N-CDs /ph-OH, Cu@N-CDs /AP-NH_2, and Cu@N-CDs /H_2O_2/AP-NH_2 /ph-OH, (B) Fluorescence spectrum of the Cu@N-CDs (i) and UV-vis absorption spectrum of the H_2O_2/AP-NH_2 /ph-OH system (ii), (d) Time-resolved decays of the Cu@N-CDs before and after addition of H_2O_2/AP-NH_2 /ph-OH system.

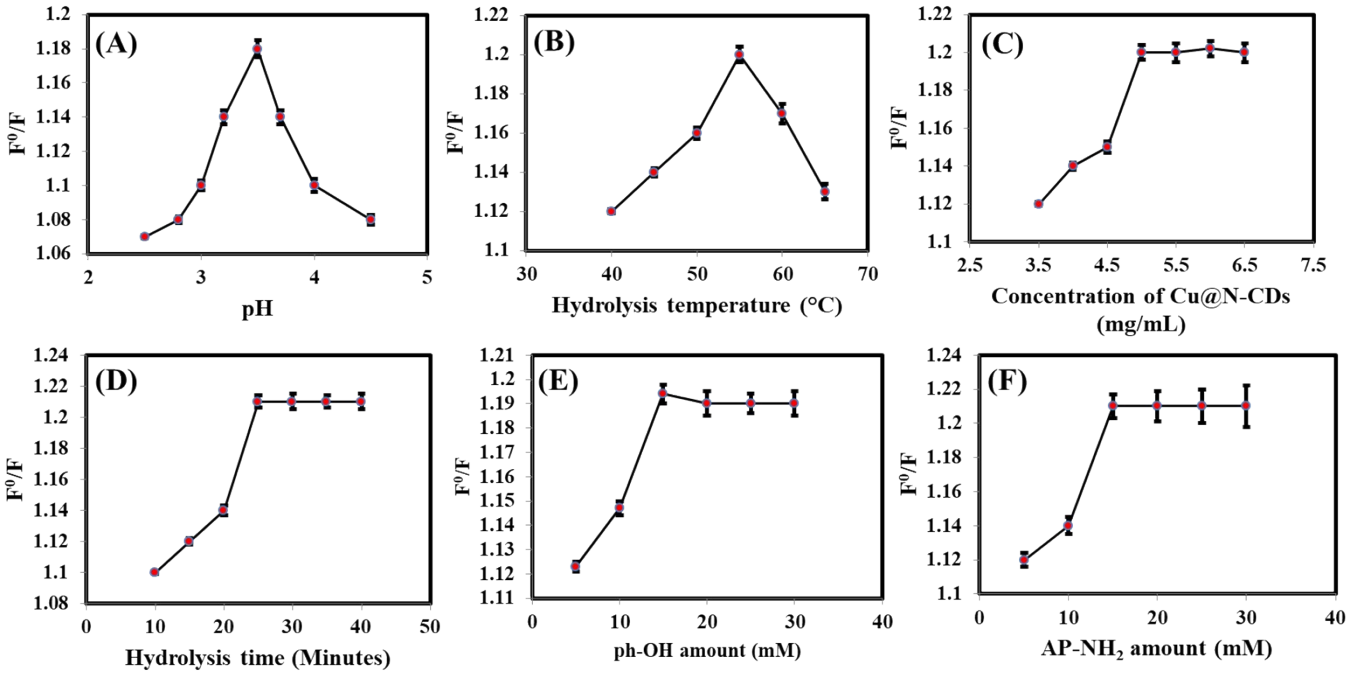

Fig.S6 The catalytic activity of Cu@N-CDs at different conditions including pH (A), temperature (B), time (C), amount of Cu@N-CDs (D), concentration of ph-OH (E), concentration of AP-NH_2 (f). Concentration of uric acid is 120 μM.

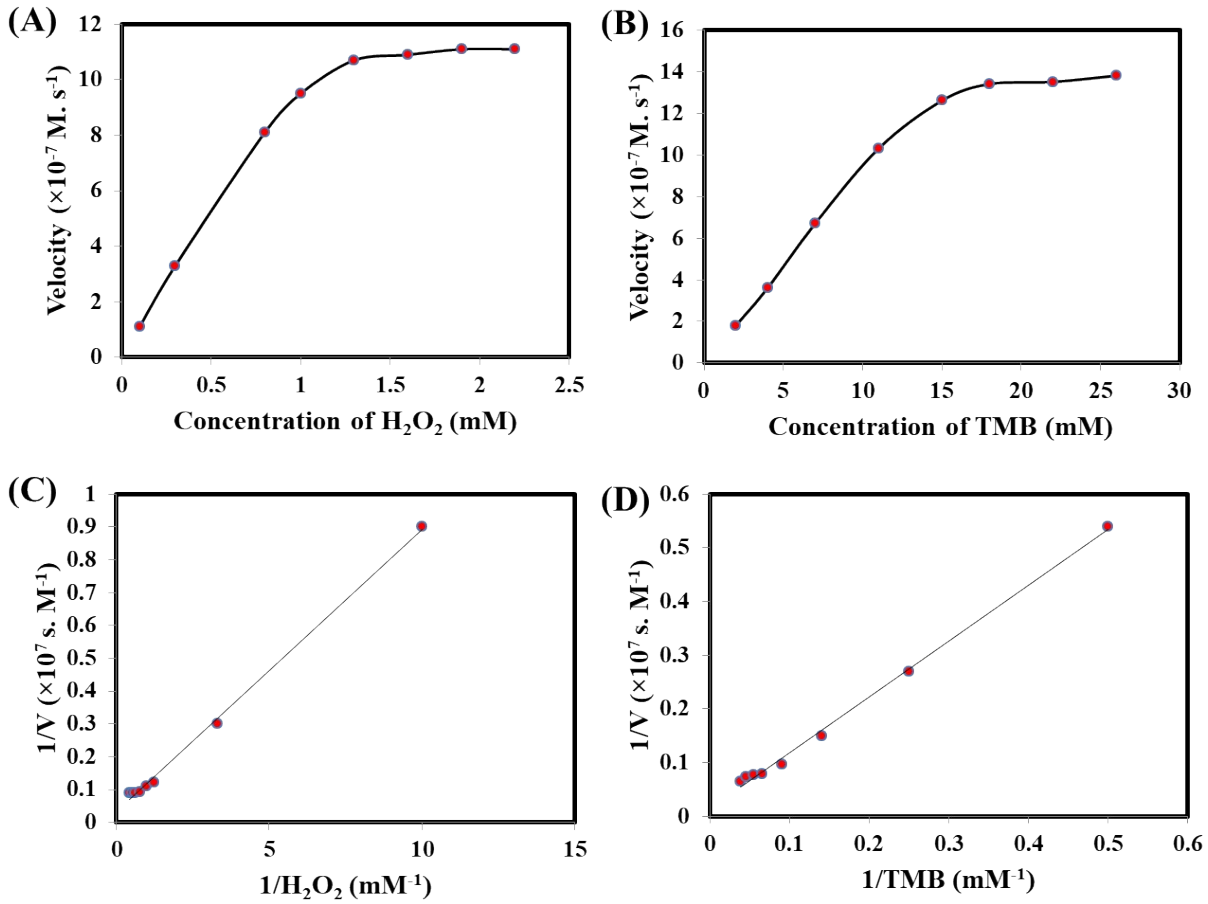

Fig.S7 Steady-state kinetic analysis using the Michaelis-Menten model (A and B) and the Lineweaver-Burk model (C and D) for Cu@N-CDs. The concentration of TMB was 12 mM and the H_2O_2 concentration was varied (0.1–2.2 mM) (A and C). The concentration of H_2O_2 was 0.8 mM and the TMB concentration was varied (2-26 mM) (B and D).