Supplementary data file

Smart Fluorometric Sensing of Metal Contaminants in Canned Foods: A Carbon Dot-Based Dual-Response System for Quantifying Aluminum and Cobalt Ions

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2.2. Instrumentation and characterization

The optical characterization of the synthesized carbon dots was probed through fluorescence and UV-Vis spectroscopic methods, wherein the fluorescence emission spectra were acquired on a Shimadzu RF-5301PC spectrofluorometer by exciting the samples at 320 nm with 5 nm slit widths, while the absorption spectra were generated using a Shimadzu 1601 PC UV-Vis spectrophotometer. The structural and morphological aspects were elucidated by transmission electron microscopy using a JEOL 2100F instrument operating at 200 kV accelerating voltage to visualize the size and shape of the carbon dots, X-ray diffraction patterns recorded with a Philips PW 1700 diffractometer, and Fourier transform infrared spectroscopy performed on KBr pellets using a Nicolet 6700 spectrometer. Furthermore, the surface chemical composition and bonding states were evaluated through X-ray photoelectron spectroscopy utilizing an ESCALAB250 spectrometer from Thermo Scientific.

2.4. Fluorescence quantum yield measurement

The quantum yield (QY) of NSDC-Dots was calculated using quinine sulfate (QS) as a reference standard dissolved in 0.1 M H_2SO_4, which has a known quantum yield of 0.54 at 360 nm. The fluorescence of NSDC-Dots was measured at an excitation wavelength of 320 nm, while maintaining absorbance values below 0.05 at 360 nm. Both the absorbance measurements and integrated fluorescence areas were then substituted into the quantum yield formula for calculation [1, 2].

$$\phi_{NSDC-Dots} = \phi_{QS} \times \frac{F_{NSDC-Dots}}{F_{QS}} \times \frac{A_{QS}}{A_{NSDC-Dots}} \times \frac{\eta_{NSDC-Dots}}{\eta_{QS}}$$

$\Phi_{NSDC\text{-}Dots}$ represents the quantum yield of NSDC-Dots, ϕ_{QS} represents the quantum yield of QS, $F_{NSDC\text{-}Dots}$ is the fluorescence intensity of NSDC-Dots, F_{QS} is the fluorescence intensity of quinine sulphate, A refers to the absorbance value and η refers to the refractive index of the solvent (double distilled water). The synthesized NSDC-Dots were dissolved in distilled water (η = 1.33) and quinine sulfate was dissolved in 0.1 M H_2SO_4 (η = 1.33).

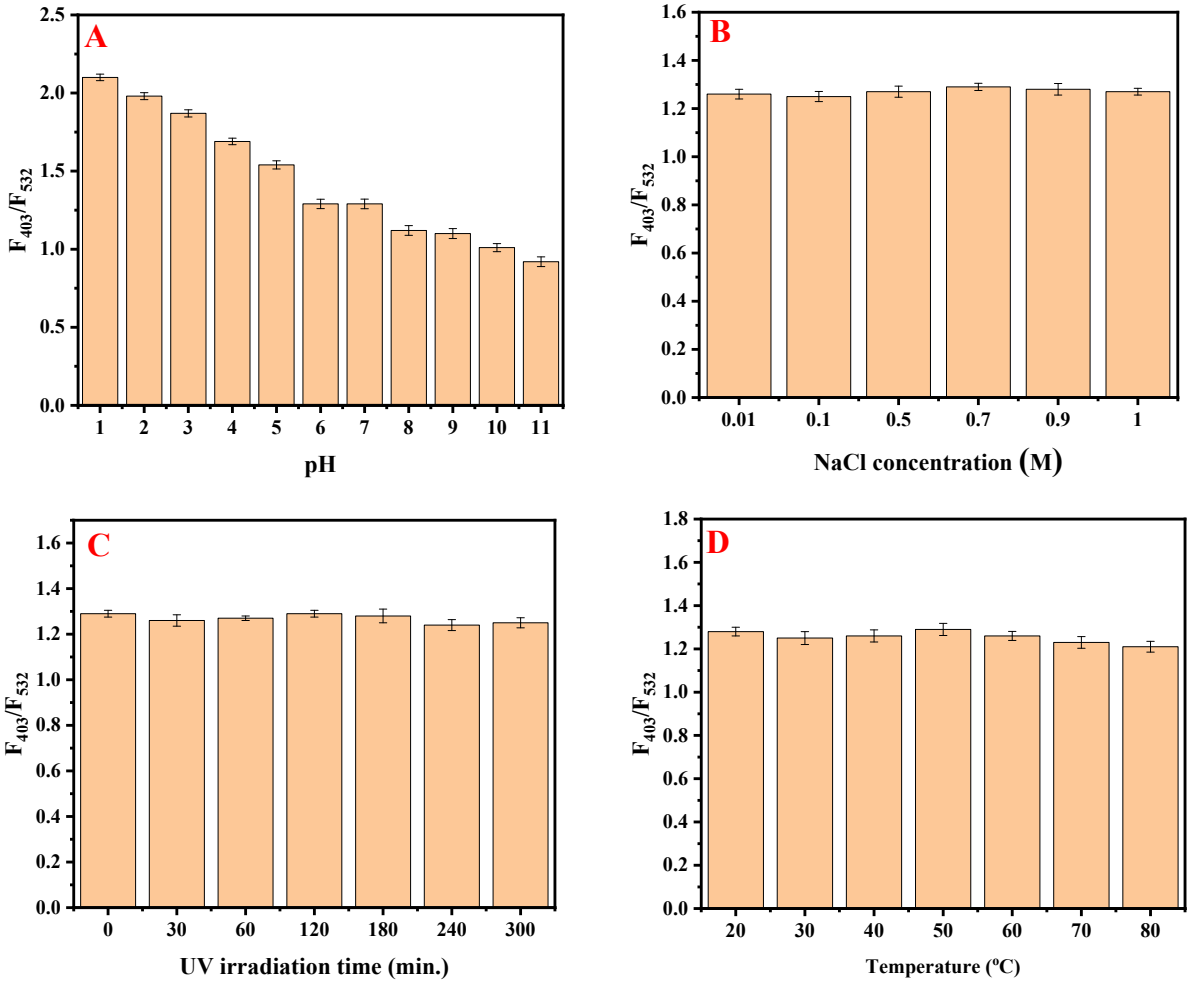

Fig. S1. Stability of the fluorescence response ratio of the prepared NSDC-Dots under various conditions: (A) effect of pH (1-11), (B) effect of NaCl concentration (0.01-1.0 M), (C) effect of UV irradiation time (0-300 minutes), and (D) effect of temperatures (20 – 80 °C).

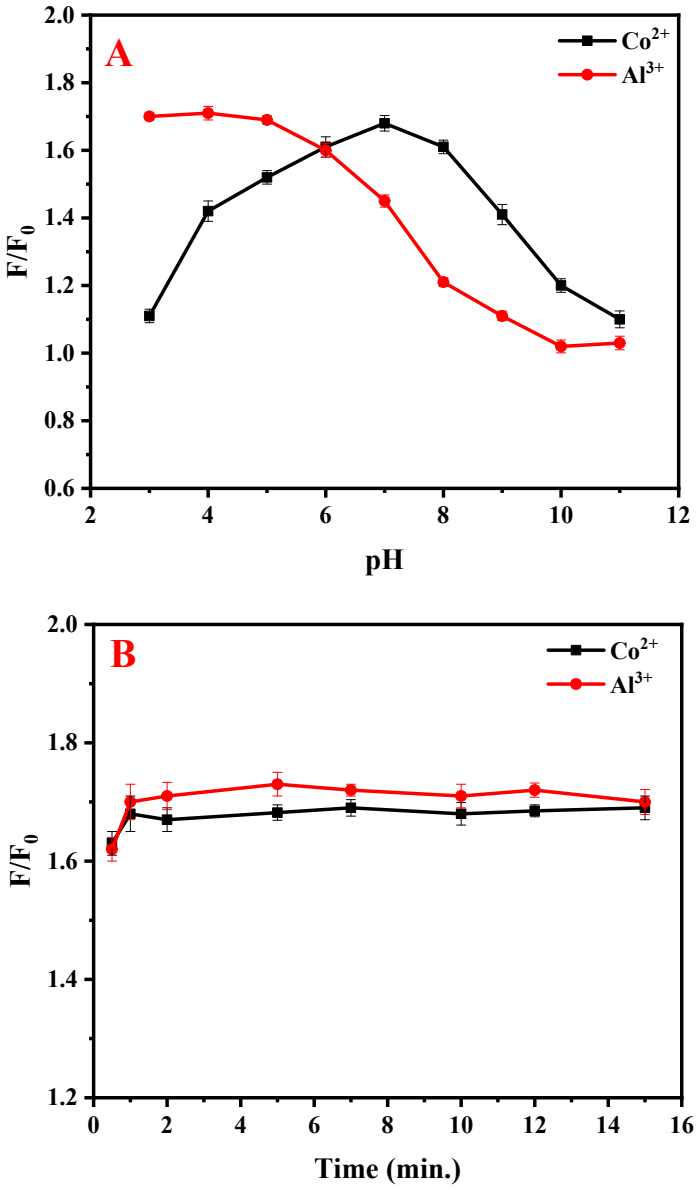

Fig. S2. (A) The effect of pH (3.0 to 11.0), (B) different reaction time (1.0 to 15.0 min.) on F/F_0 of NS-CDs upon addition of Al^{3+} or Co^{2+}.

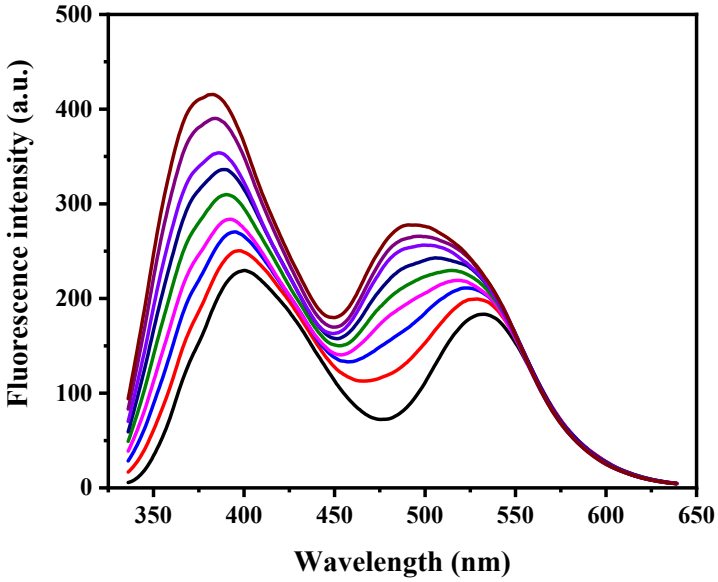

Fig. S3. Fluorescence spectra of NSDC-dots for simultaneous of Co^{2+} in the concentration range from 0 to 0.7 μM and Al^{3+} in the concentration range from 0 to 1.6 μM.

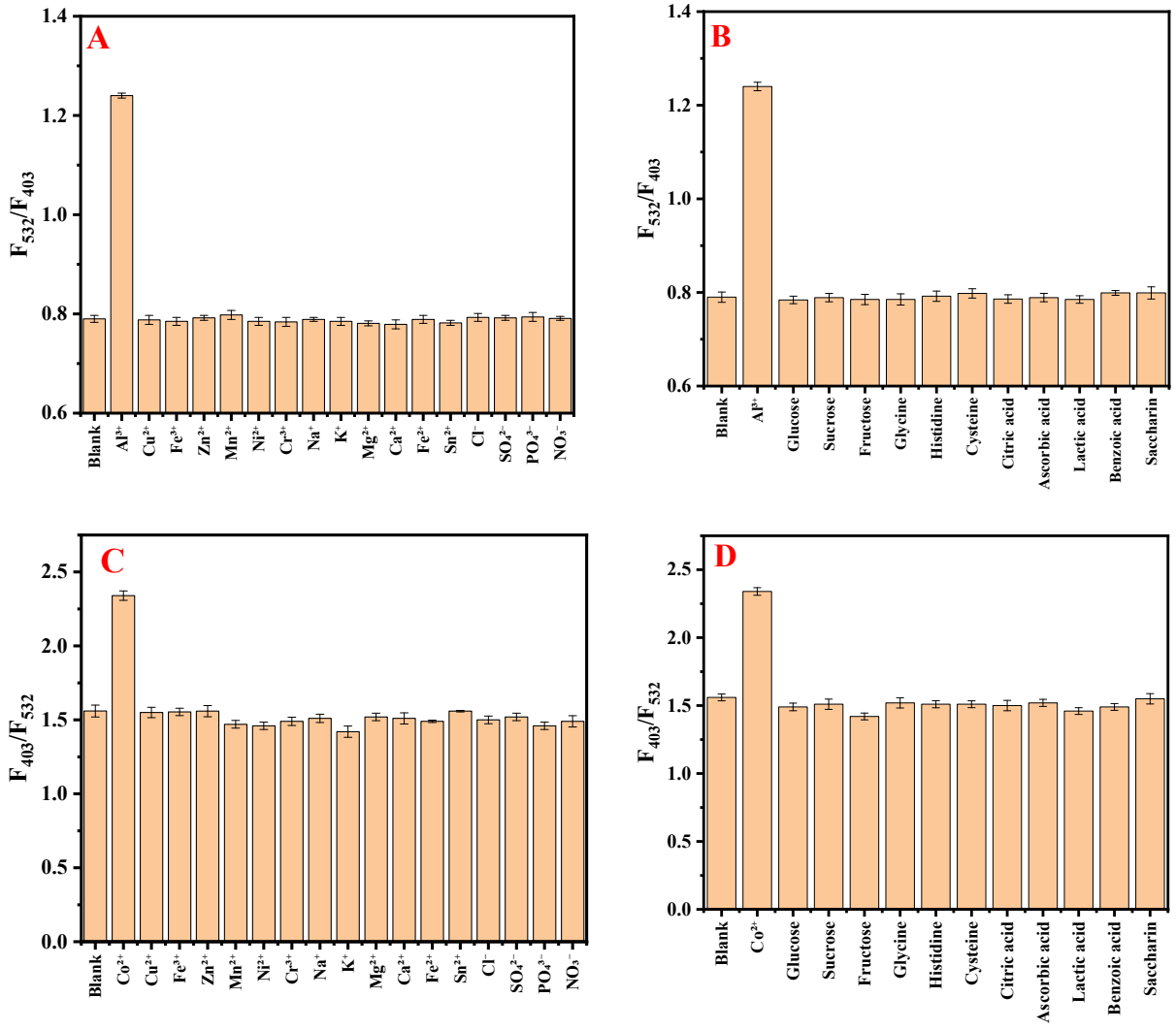

Fig. S4. Response of the NSDC-Dots system to aluminum ions and different (A) metal ions and anions, and (B) organic molecules. Response of the NSDC-Dots system to cobalt ions and different (C) metal ions and anions, and (D) organic molecules.

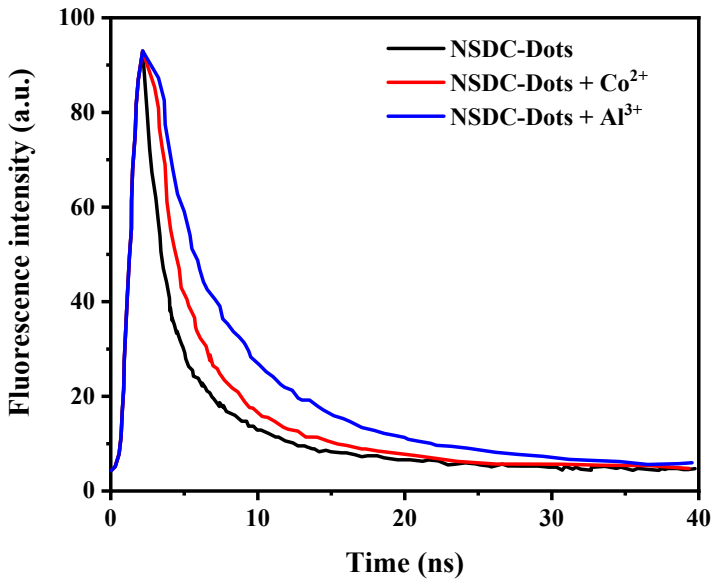

Fig. S5. Fluorescence lifetime of NSDC-Dots, NSDC-Dots + Al^{3+}, and NSDC-Dots Co^{2+}.

References

1. W. Liu, R. Zhang, Y. Kang, X.-y. Zhang, H.-j. Wang, L.-h. Li, H.-p. Diao and W.-l. Wei, *New Carbon Materials*, 2019, **34**, 390-402.

2. K. Qu, J. Wang, J. Ren and X. Qu, 2013, **19**, 7243-7249.