Supporting Information (ESI) for

pH sensing and bioimaging using green synthesized carbon dots from black fungus

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Experimental section

Materials

All the reagents and chemicals were of analytical grade and used as received without further purification. The reagents were obtained from Sigma-Aldrich Chemical Co. High purity water with a resistivity of 18.2 MΩ cm was obtained from the United States Milli-Q purification system (Millipore, MA, USA). Black fungus was purchased from local supermarket (Harbin).

Preparation of CDs

Firstly, black fungus was grounded and mixed with 30 mL of distilled water. After ultrasonic treatment for 10 min, the mixture was then poured into a 50 mL Teflon reaction vessel and autoclaved at 200 ^{o}C for 4 h. After natural cooling to room temperature, the reaction yielded a kind of brown solution with strong blue fluorescence. After purification by filter and dialysis, pure CDs were obtained. The product was centrifugated at 8000 rpm for 10 min and filtered by microporous membrane. Solid-phase CDs powders could also be dried to a solid by freeze-drying.

To obtain optimal preparation conditions, the fluorescent quantum yield (QY) was used to evaluate the CDs obtained from fungus. From the controlled experiments conducted, we prepared the CDs at 200 ^{o}C for 4 h.

Characterization

The morphological character and size distribution of CDs from black fungus were investigated by a JEOL JEM-2100 transmission electron microscope (TEM) with an accelerating voltage of 200 kV. X-ray powder diffraction (XRD) spectrum was performed on a Shimadzu XRD-6100 spectrometer (Kyoto, Japan). Surface chemistry features were obtained from the Fourier transform infrared spectra (FT-IR) accomplished using the KBr powder as the sample matrix on a Nicolet AVATAR 360 FT-IR spectrophotometer. X-ray photoelectron spectroscopy (XPS) analysis was performed on a Thermo Fisher K-Alpha spectrometer (Thermo Fisher, USA). Fluorescence spectra were carried out at room temperature on a PC spectrophotometer (Shimadzu RF-5301) equipped with a xenon lamp. UV-vis absorption spectra were obtained by a Shimadzu UV-2550 spectrophotometer.

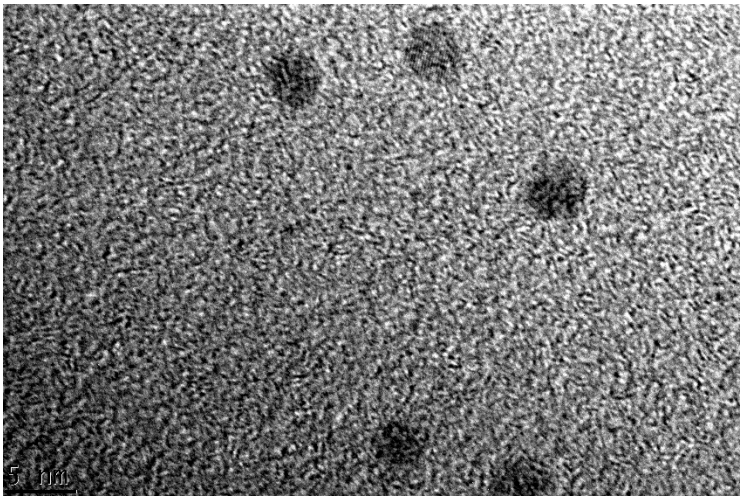

Figure S1. HRTEM image of CDs

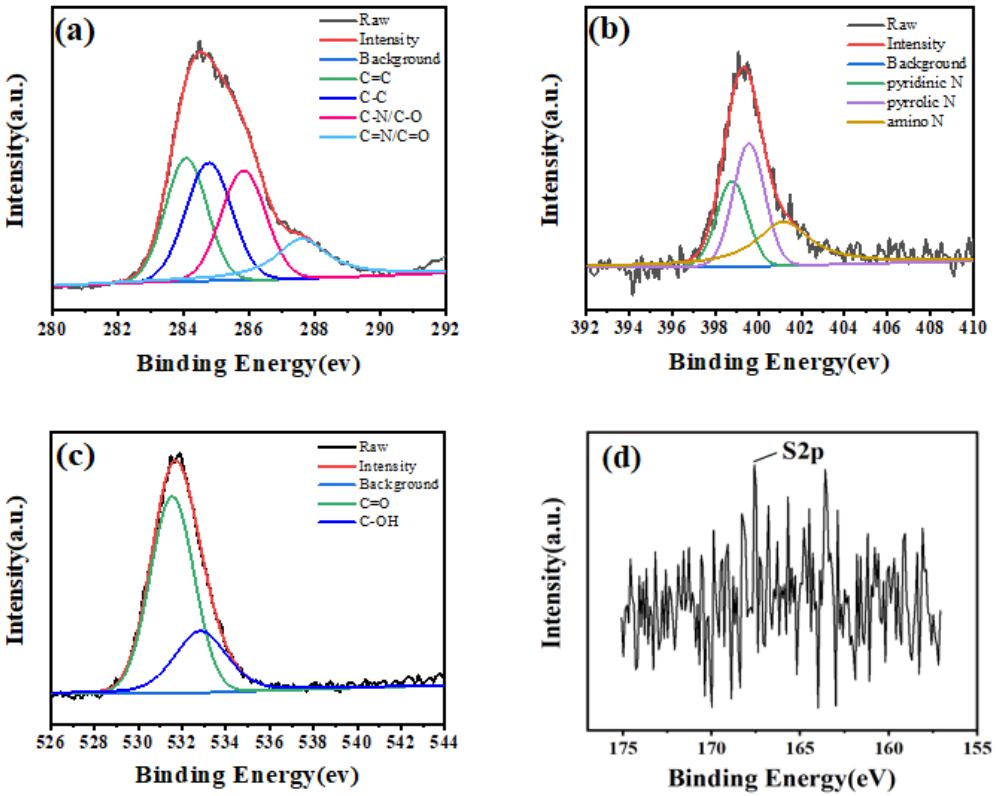

Figure S2. High-resolution XPS spectra of (a) C, (b) N,(c) O,and (d) S

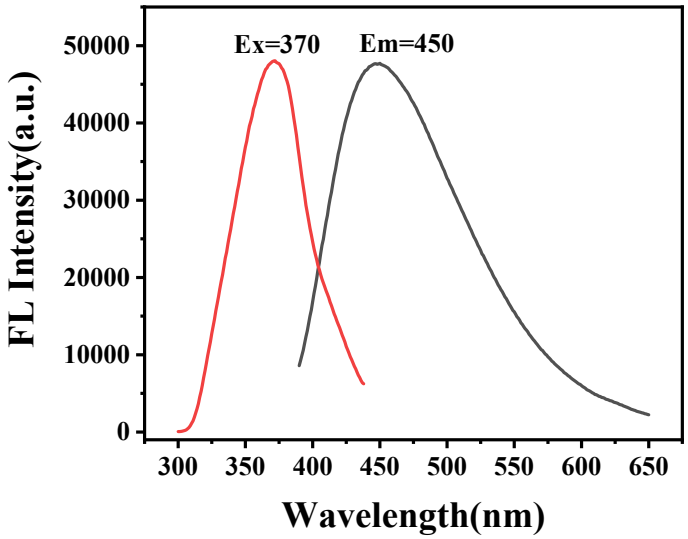

Figure S3. FL excitation and emission spectra of CDs.

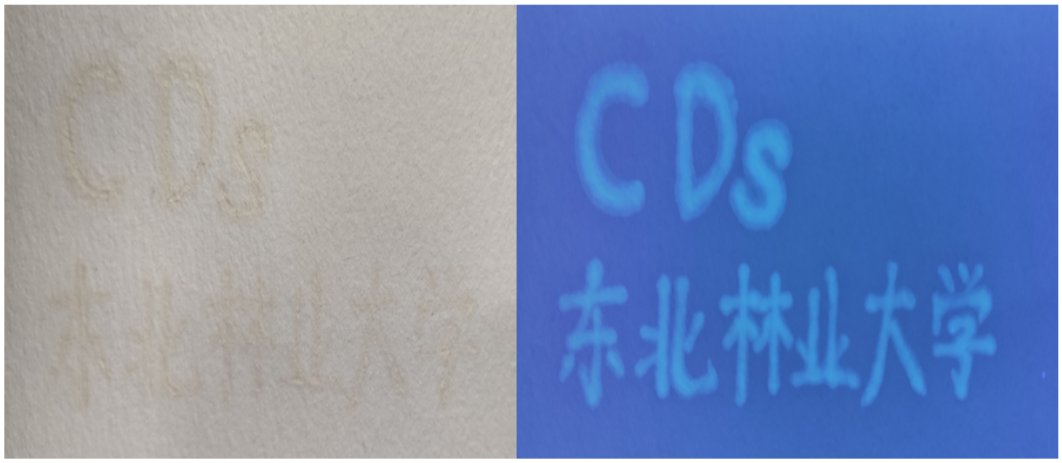

Figure S4. Image of CDs and fluorescence patterns under visible light and a UV beam of 365 nm.

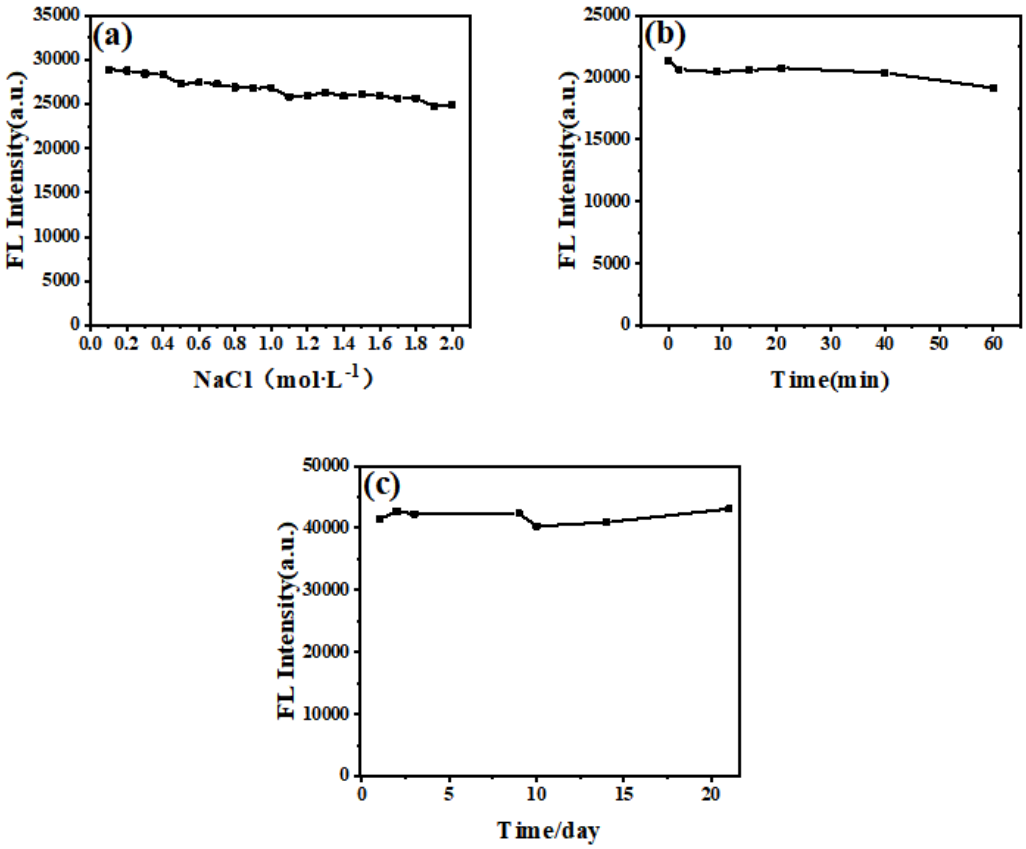

Figure S5. (a) Effect of the concentration of NaCl from 0 to 2 M and increase with 0.1 M increments on the FL intensities of CDs. (b) FL intensity of the as-prepared CDs during continuous excitation at 365nm with a UV beam. (c) FL stability of the as-prepared CDs for 20 days at room temperature in air-tight closed tubes.

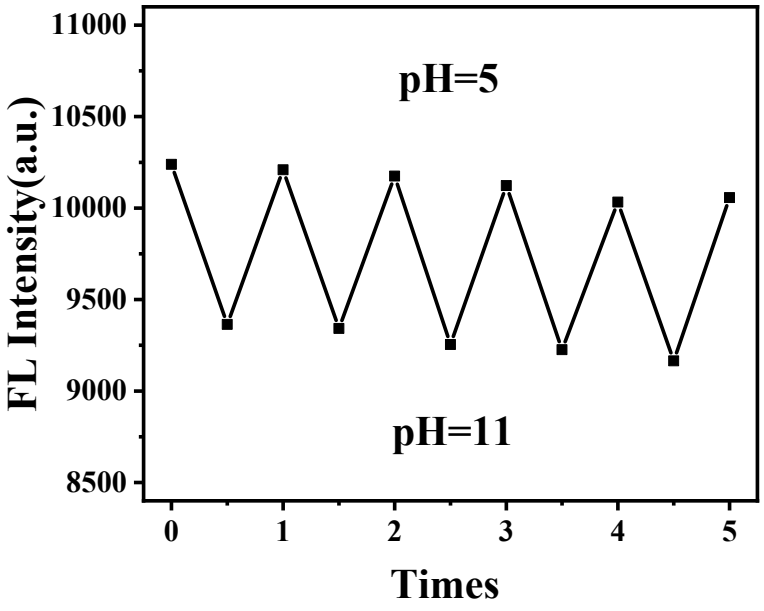

Figure S6. FL intensity upon the cyclic switching of CDs under alternating conditions of pH =5 and pH = 11.

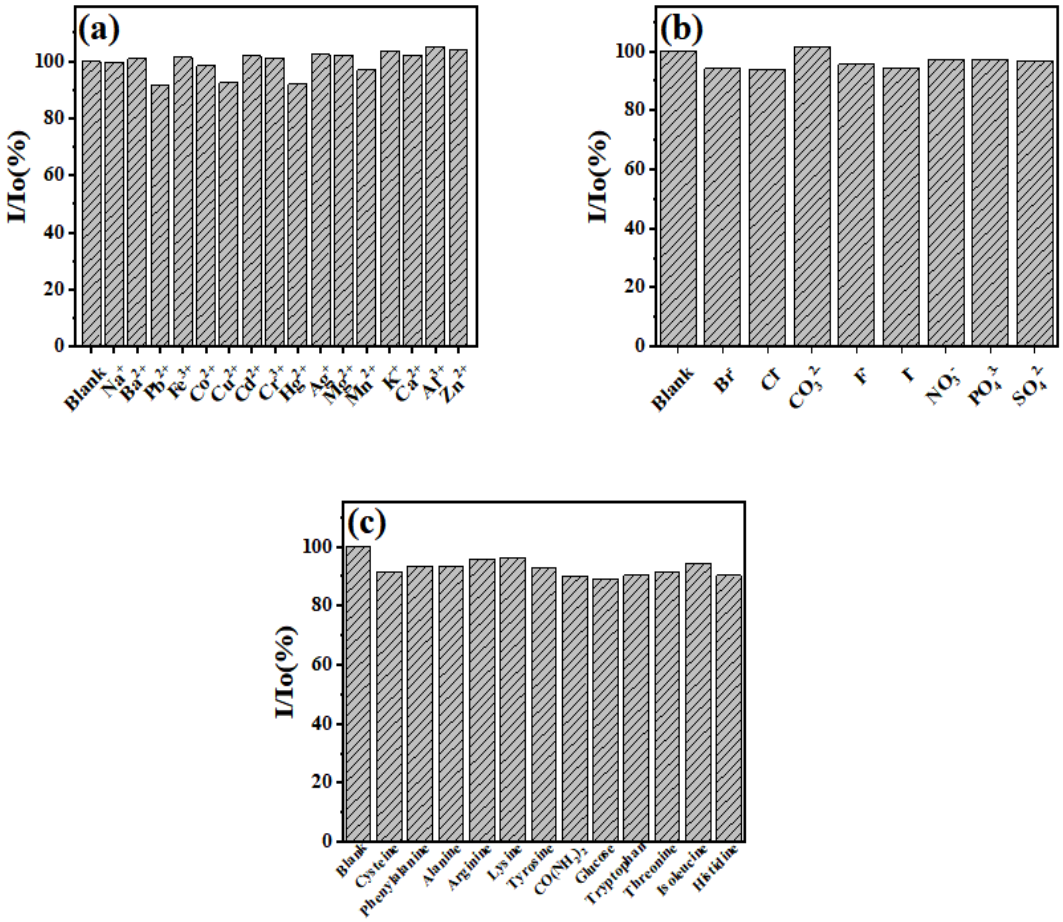

Figure S7. Selectivity experiments of the CDs sensor towards (a) cation ions, (b) anion ions and (c) various compounds.

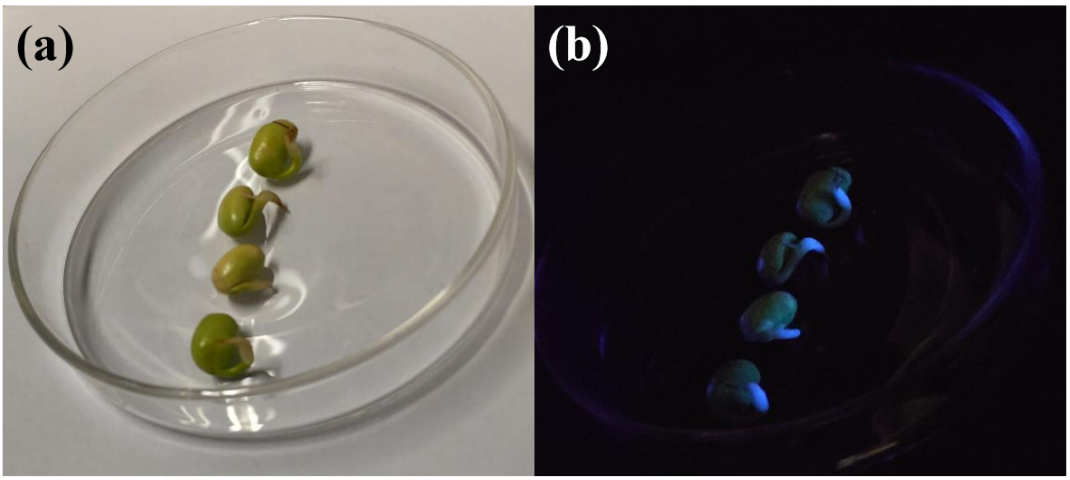

Figure S8. Photographs of soybeans grown in water containing CDs, illuminated with (a) visible and (b) UV light, respectively.

Table S1 Detail parameters and experimental results for the CDs from different reaction time

Reaction temperature (℃)	Reaction time (h)	The amount of black fungus (g)	Solvent	QY (%)
180	1	0.5530	30mL water	3.29
180	2	0.5530	30mL water	4.64
180	3	0.5562	30mL water	5.60
180	4	0.5575	30mL water	6.78
180	5	0.5568	30mL water	6.09
180	6	0.5571	30mL water	6.04
180	7	0.5568	30mL water	5.88

Table S2 Detail parameters and experimental results for the CDs from different reaction temperature

Reaction temperature (℃)	Reaction time(h)	The amount of black fungus (g)	Solvent	QY (%)
140	4	0.5539	30 mL water	1.58
160	4	0.5530	30 mL water	0.63
180	4	0.5520	30 mL water	6.78
200	4	0.5481	30 mL water	11.30
220	4	0.5560	30 mL water	12.31

Table S3 Compared with some biomass carbon dots research results

Raw materials	Preparation methods	QY (%)	Applications	Reference
Nigella sativa seeds	Hydrothermal	8.0	Dual sensing of tetracycline and L-Lysine	S[1]
Waste tea residue	Chemical oxidation	2.47	Detection of tetracycline	S[2]
Eggshell membrane	Hydrothermal	9.6	Determination of Hg^{2+} and yeast cell imaging	6
Green tea leaf residue	Combining pyrolyzation at high temperature and oxidation by concentrated H_2SO_4	14.8	Detection of gefitinib	10
Pea	Hydrothermal	2.54	Fungi imaging	11
Betel leaves	Hydrothermal	12	Detection of Fe^{3+} and Bioimaging	12
Black fungus	**Hydrothermal**	**11.3**	**pH sensing and bioimaging**	**This work**

References

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Table S4 pH detection in real water samples

Sample	pH_1 (obtained by the proposed method)	pH_2 (measured by a pH meter)
Nongfu Spring	8.14	7.99
Soda Water	8.08	8.56
Tap water	7.43	7.18