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Facile synthesis of red-emitting carbon dots from pulp-free lemon juice for bioimaging

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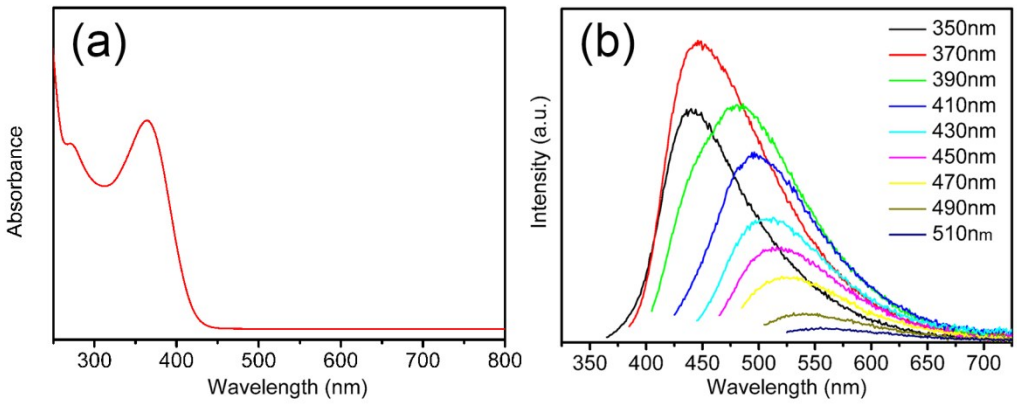

Fig. S1 (a) UV-visible absorption spectra and (b) PL emission spectra of the blue-emitting CDs produced by hydrothermally treating pulp-free lemon juice.

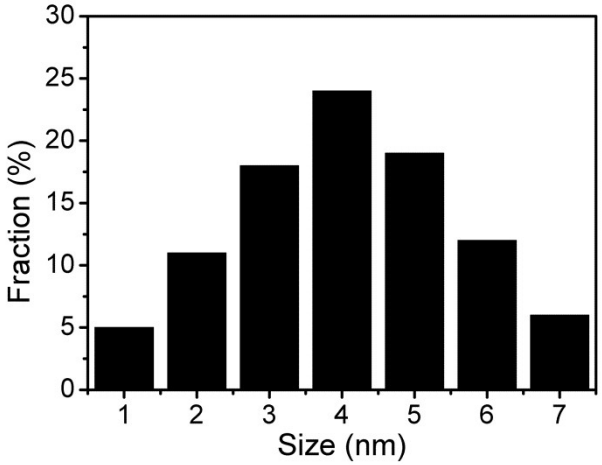

Fig. S2. Size distribution histogram of the R-CDs.

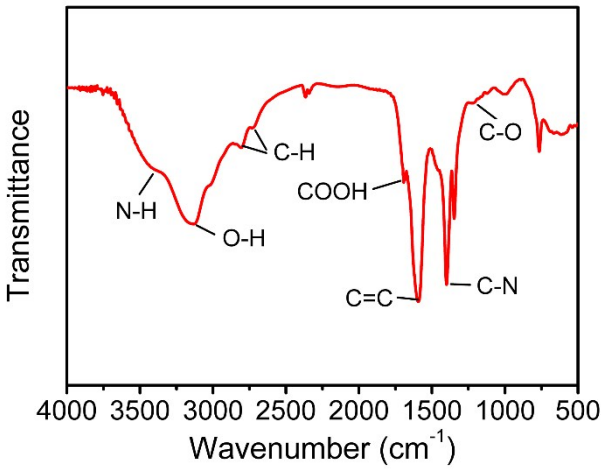

Fig. S3 FT-IR spectra of the as-obtained R-CDs.

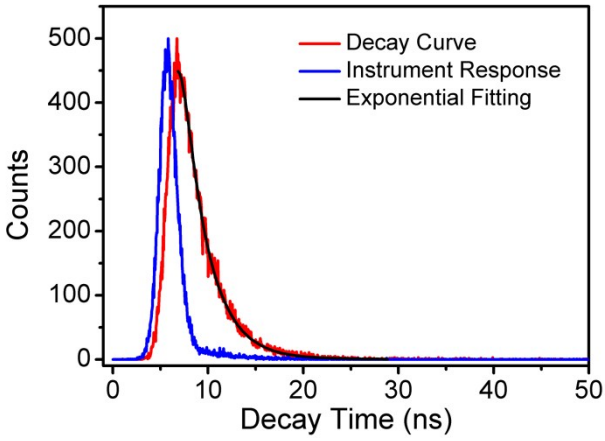

Fig. S4 Time-resolved PL spectra of the R-CDs measured by monitoring the emission of 631 nm when excited at 533 nm.

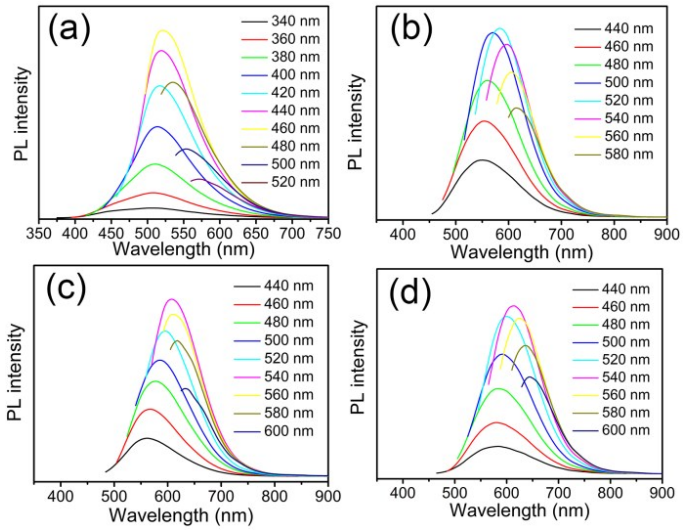

Fig. S5 (a-d) PL spectra of the as-obtained CD mixtures synthesized with different amounts of ethanol from 3.0 to 6.0, 9.0 and 12 mL, respectively.

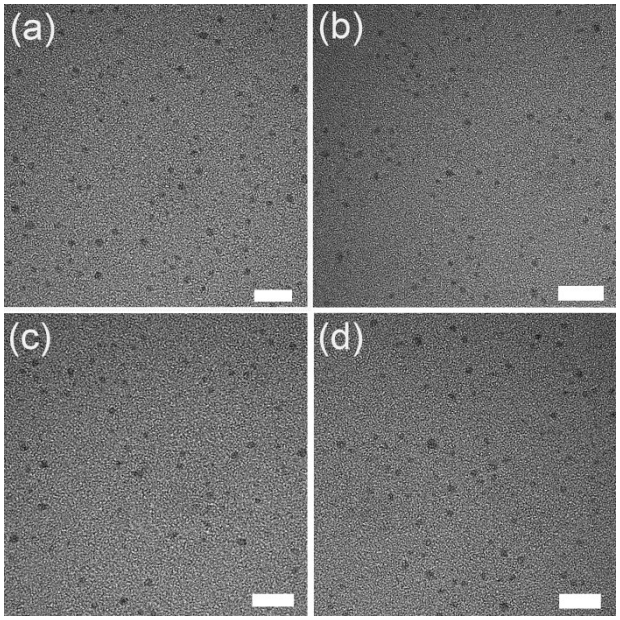

Fig. S6 (a-d) TEM images of the as-obtained CD mixtures synthesized with different amounts of ethanol from 3.0 to 6.0, 9.0 and 12.0 mL, respectively. The scale bar represents 20 nm.

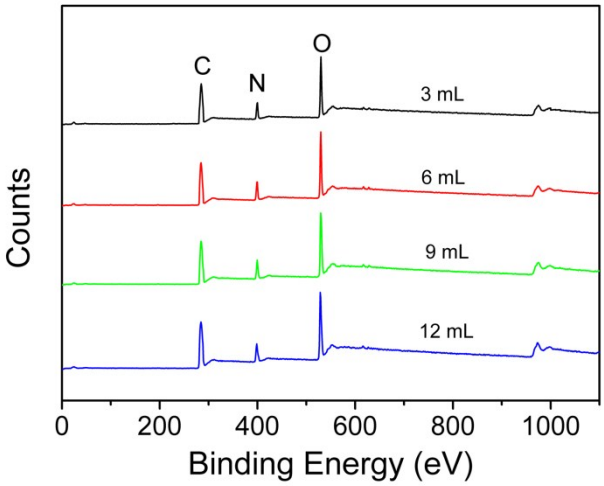

Fig. S7 XPS spectra of the as-obtained CD mixtures synthesized with different amounts of ethanol from 3.0 to 6.0, 9.0 and 12.0 mL, respectively.

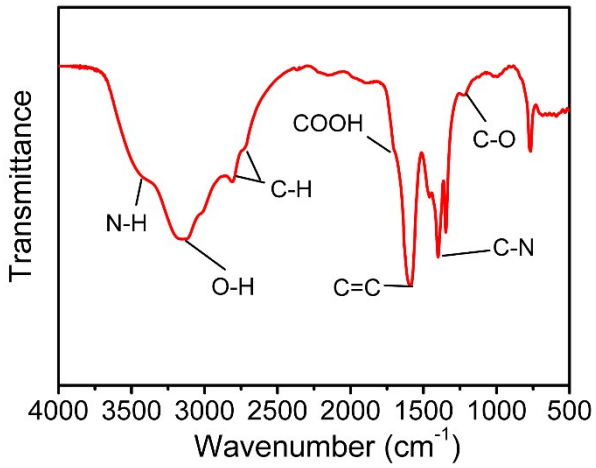

Fig. S8 FTIR spectra of the $NaBH_4$ reduced R-CDs.

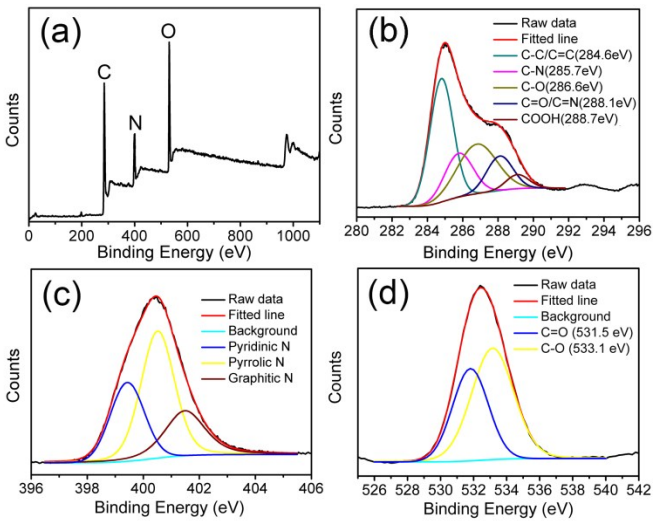

Fig. S9 (a) XPS spectra of the $NaBH_4$ reduced R-CDs. (b-d) High-resolution XPS spectra of the C1s, N1s, and O1s of the $NaBH_4$ reduced R-CDs, respectively.

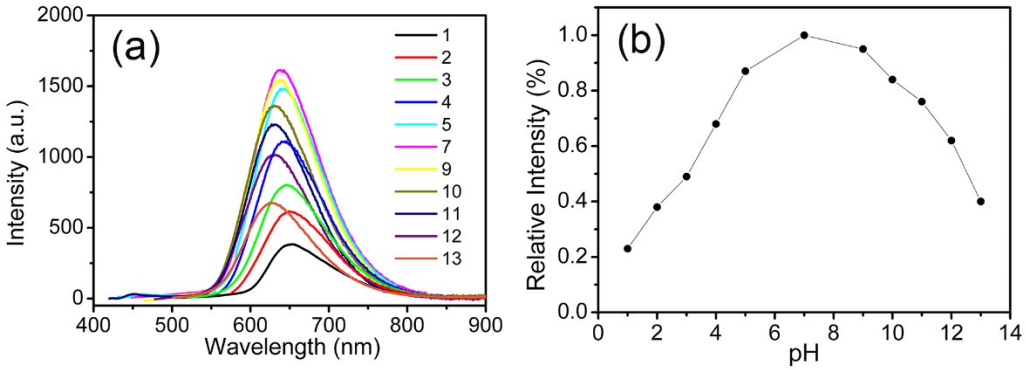

Fig. S10 (a) PL spectra of the R-CDs at different pH values under excitation of 533 nm. (b) Variation in the emission intensity with the different pH values.

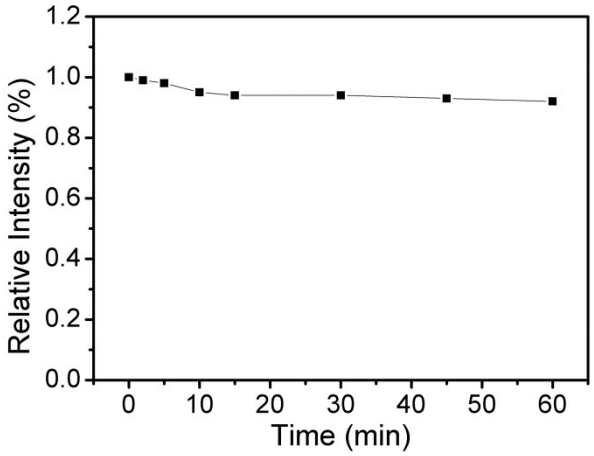

Fig. S11 Relative PL intensity of the R-CDs under continuous irradiation of 365 nm UV light.

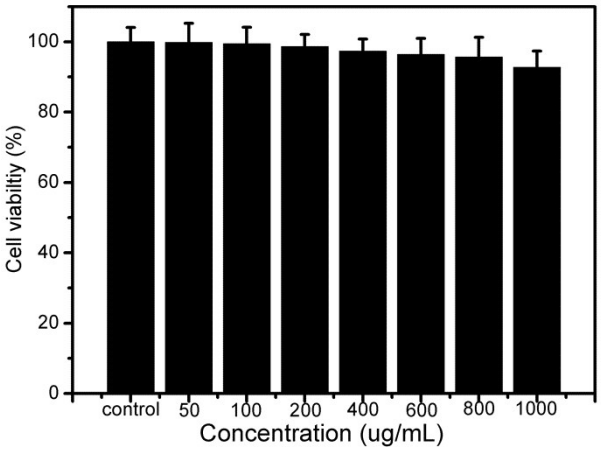

Fig. S12 Cytotoxicity assessment of the R-CDs with the standard MTT assay toward HeLa cells.

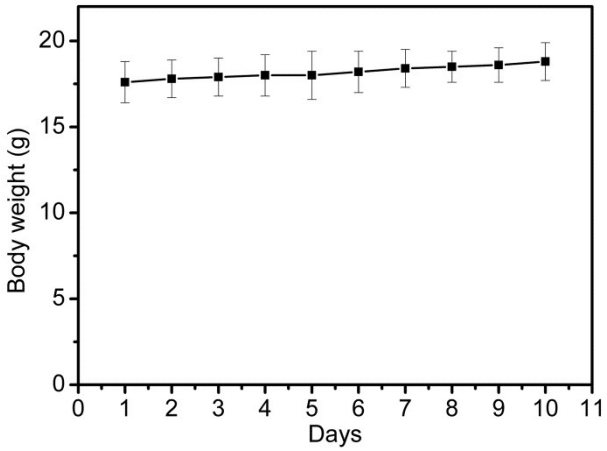

Fig. S13 Body weight changes of mice after subcutaneous injection of the R-CDs aqueous solution.

Tab. S1 Summary of PL lifetimes of the R-CDs as indicated.

λ_{ex}/nm	λ_{em}/nm	τ/ns	B[%]	χ^2
533	631	2.38	100	1.04

Tab.S2. The C, N, and O element contents of R-CDs and $NaBH_4$ reduced R-CDs determined by XPS results.

Sample	C (%)	N (%)	O (%)
CDs (3 mL)	66.4	10.3	23.3
CDs (6 mL)	66.1	11.2	22.7
CDs (9 mL)	64.8	11.8	23.4
CDs (12 mL)	64.5	12.4	23.1

Tab. S3 The C, N, and O element contents of R-CDs and $NaBH_4$ reduced R-CDs determined by XPS results.

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Sample	C (%)	N (%)	O (%)
R-CDs	60.9	15.4	23.7
r-CDs	65.4	14.2	20.4

Tab. S4 XPS data analyses of the C1s spectra of the R-CDs and $NaBH_4$ reduced R-CDs.

Sample	C=C/C-C (%)	C-N (%)	C-O (%)	C=O/C=N (%)	COOH (%)
R-CDs	38.53	23.97	17.78	8.67	11.05
r-CDs	40.50	24.12	24.79	6.30	7.38

Tab. S5 Previous literature concerning red luminescent CDs.

Ref.	Journal	Starting Materials	Synthetic Method	PL Peak (nm)	Ex peak (nm)	QY in water (%)
1	Adv. Mater. 2015, 27, 1663	Carbon fibers	acid oxidation	610	360	2
2	Adv. Mater. 2015, 27, 4169	Polythiophene phenylpropionic acid	hydrothermal	640	Null	2.3
3	Adv. Mater. 2017, *29*, 1604436	Citric acid diaminonaphthalene	solvothermal	604	490	Null
n	Angew. Chem. Int. Ed. 2015, 54, 5360	p-phenylenediamine	solvothermal	604	510	Null
5	Chem. Eur. J. 2015, 21, 18993	Bagasse	acid oxidation	630	372	unsolvable
6	Chem. Eur. J. 2016, 22, 14475	p-phenylenediamine	microwave	615	480	15
7	Chem. Commun. 2015, 51, 2544	Grapite	electrochemical exfoliation	610	500	2
8	Chem. Mater. 2016, *28*, 8659	Citric acid	microwave	640	540	16
9	Our work	Lemon juice	solvothermal	631	533	28