Electronic Supplementary Information (ESI)

Synthesis of Carbon Quantum Dot from Cabbage with Down- and Up-Conversion Photoluminescence Properties: Excellent Imaging Agent for Biomedical Application

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1. Cytotoxicity experiment

HaCaT cells were seeded in 96 different well plates containing 200 µl/well (3,000 cells/well). The medium of cultured cells was replaced after 3h with a fresh medium. The cultured cells were then treated (triplicate wells per condition) by adding 100µl of 1000, 700, 500, 300, 100 and 20 µg/ml of the CQD in Defined K-SFM medium. Simultaneously, the Defined K-SFM medium alone was added to another set of cells as the solvent control (Defined K-SFM). The cells were then incubated for another 24 h prior to the addition of 20 µl of 2.5 mg/ml MTT solution into each well. The incubation was continued for 1 h before the medium was removed. DMSO (100 µl) was added to each well and mixed to ensure dissolving of the crystal formazan before the absorbance at 570 nm was measured. The viability experiments were done in triplicates and each data point represents the average of at least 3 independent experiments. The distributions of the data are abnormal. The data were analysed using Statistical Analysis System (SAS) and expressed as mean ± SD. One way analysis of variance technique was applied to observe the significance between the groups. Entire statistical analysis was carried out at $p < 0.05$.

Table S1. Comparison of percentage of Yield of CQD from cabbage and other natural sources.

Source	Amount of Raw materials	Obtained CQD	Yield (%)	References
Orange Juice	40 mL Juice	400 mg	-----	6
Orange peel	2 g	246 mg	12.3	7
Strawberry	35 mL Juice	Not specified	-----	11
Soybean ground	1 g	10 mg	1	12
Cocon Silk	1g	Not specified	-----	13
Food waste	100 Kg	120 g	0.12	17
Tomato	4 g	500 mg	12.5	30
Cabbage	**5 g**	**353.8 mg**	**7.07**	**This work**

2. Quantum Yield of cabbage derived CQD:

Quinine sulfate in 0.1 M H_2SO_4 (literature quantum yield 0.54 at 360 nm) was preferred as a standard. The quantum yield of CQDs in water was calculated according to the following equation:

$$\varphi_x = \varphi_{std}[I_x/A_x][A_{std}/I_{std}][\eta_x/\eta_{std}]^2$$

Where φ is the quantum yield, I is the measured integrated emission intensity, η is the refractive index, and A is the optical density. The subscript "*std*" refers to the parameters of standard quinine sulfate. In order to minimize re-absorption effects, absorption in the 10 mm fluorescence cuvette was kept below 0.10 at the excitation wavelength (360 nm). The sample of CQD and qunine sulfate which absorption intensity was recorded below 0.10 (Fig.S1a), was excited at 360 nm to record their emission spectra at 428 nm and 450 nm respectively (Fig.S1b).

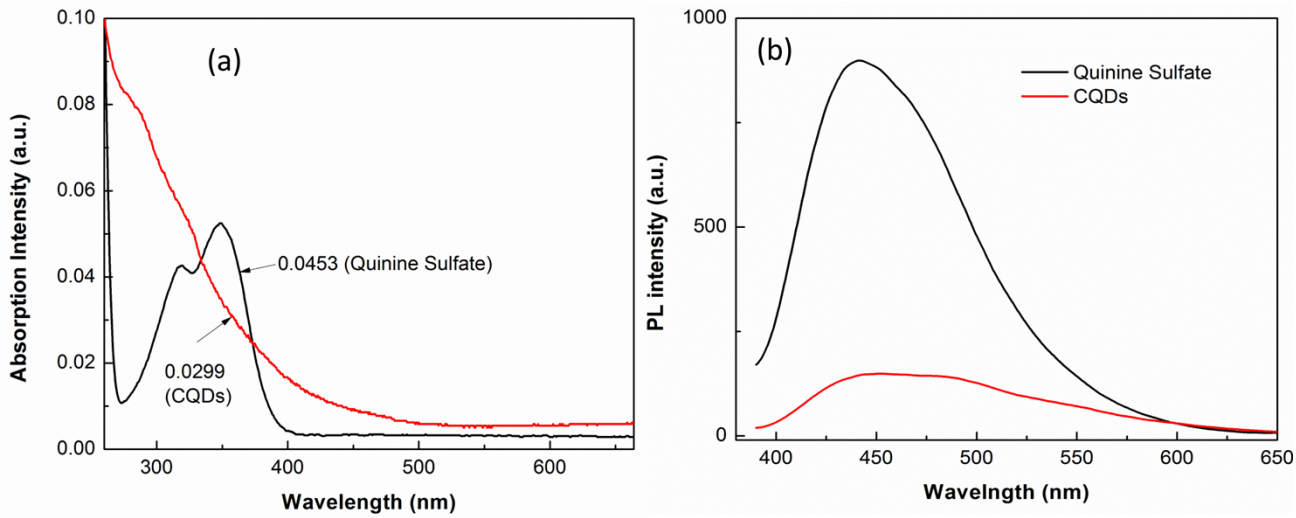

Fig.S1. Absorption and emission spectra of CQDs and quinine sulfate

The measured integrated emission intensity, optical density and refractive index from literature was placed in the Table.S2 to calculate the quantum yield of CQD.

Table S2. Required experimental data for quantum yield calculation of CQD

φ_{std}	I_{std}	I_x	A_x	A_{std}	η_x (H_2O)	η_{std} (H_2O)	Calculated QY (φ_x)
0.54	18205	0.0299	0.0453	90008.73	1.33	1.33	0.1654

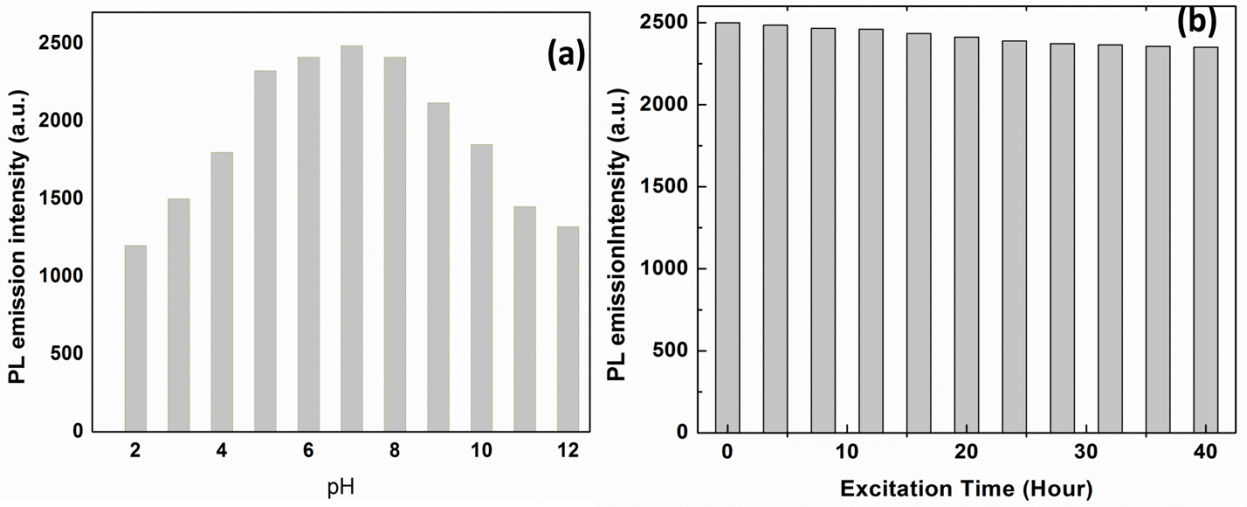

Fig.S2. pH sensitivity of CQDs (a) and UV irradiation effect on PL of CQDs over 40 hours (b)

Table S3. Comparison of Cytotoxicity of CQD from cabbage and other sources for cell imaging in biomedical application.

Imaging agent	Tolerable range (cell viability)	Administered Dose(µg/ml)	Cell Type	Incubation Time	References
Carbon Quantum dots	100-1500 ((>90%)	200	NIH3T3	24	12
	5-80(>90%)	40	Hela	24	13
	25-400 (>90%)	400	HeLa	4	14
	20-320(>90%)	300	NIH-3T3	4	16
	200-2000(>90%)	500 and 1000	HepG2	24	17
	5-100 (<90%)	75	HeLa	24	18
	20-500 (>90%)	**500**	**HaCaT**	**24**	**This work**