Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

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Supporting Information for

Electrochemical Synthesis of Phosphorus-Doped Graphene Quantum Dots for Free Radicals Scavenging

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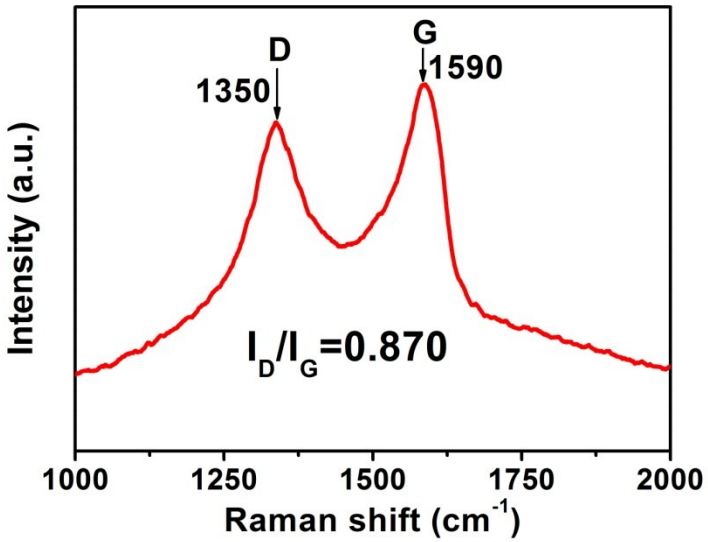

Figure. S1. The Raman spectrum of GQDs, typical D and G bands are observed near 1350 and 1590 cm^{-1}, respectively, which are corresponding to the D and G band of graphene structure. The intensity ratio I_D/I_G is 0.870.

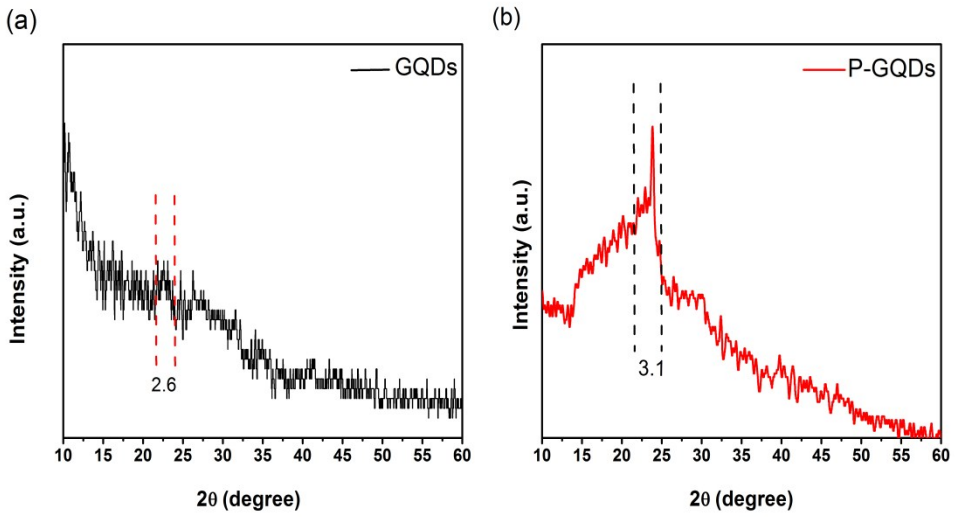

Figure. S2 The XRD spectra of the GQDs and P-GQDs, the broad diffraction peak at around 24°, which was corresponded to (002) peak of graphite[22], could be seen in GQD and P-GQD. However, the full width at half maximum of the peak for P-GQDs (3.1°) is widen than that of P-GQD (2.6°), indicating more defects were introduced to P-GQDs.

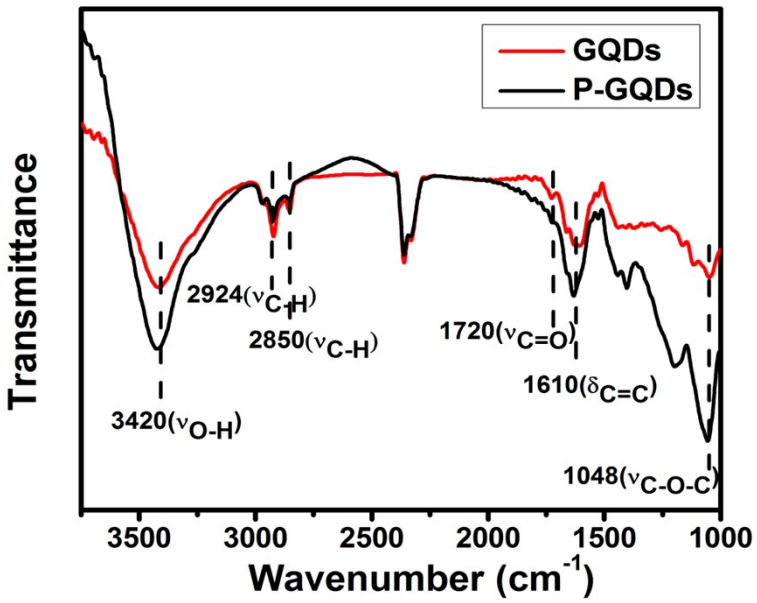

Figure. S3. The FT-IR spectra of GQDs (red) and P-GQDs (black) made from PBS and sodium phytate electrolyte, respectively. The distinct peaks at 1048cm^{-1}, 1610cm^{-}

^{1}, 1720cm^{-1}, 2850cm^{-1}, 2924cm^{-1} and 3420 cm^{-1} are attributed to C-O-C, C=C, C=O, symmetrical peak of CH_2, anti-symmetric peak of the CH_2 and O-H, respectively. The content of the C-O-C in the GQDs is far less than that in P-GQDs.

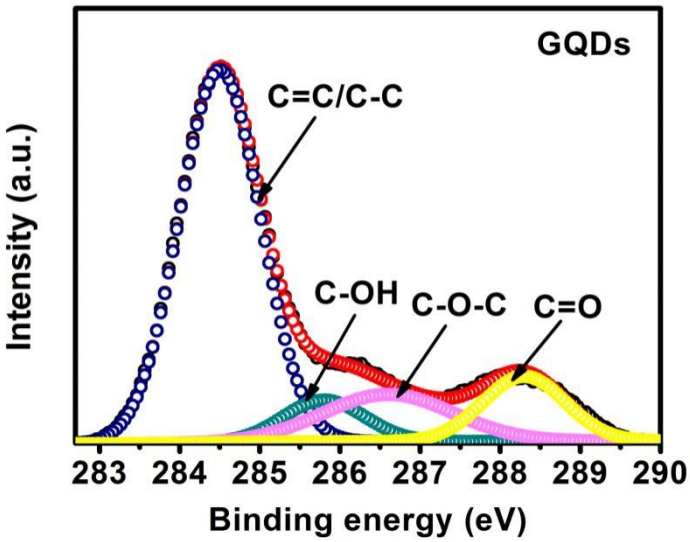

Figure. S4. High resolution XPS spectrum of the C1s of the GQDs made from PBS electrolytes. The C1s XPS spectrum (Fig.2C) could be de-convoluted into four peaks at 284.5eV (C=C/C-C), 285.9eV (C-OH), 286.7ev (C-O-C) and 288.3eV (C=O), among which the content of C-O-C is less than that in P-GQDs.

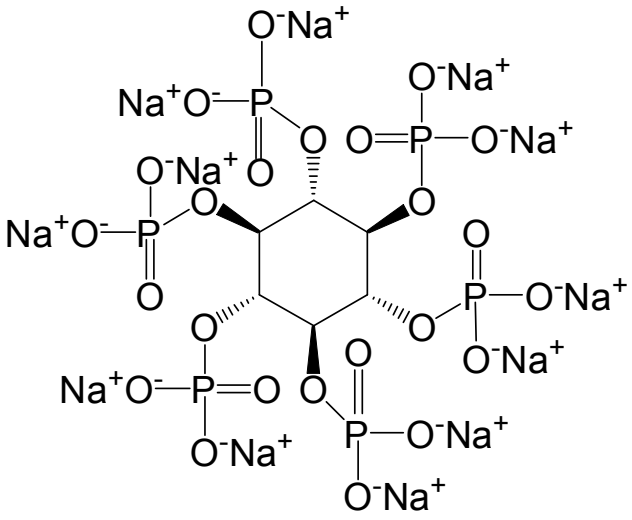

Figure. S5. Molecular structure of sodium phytate

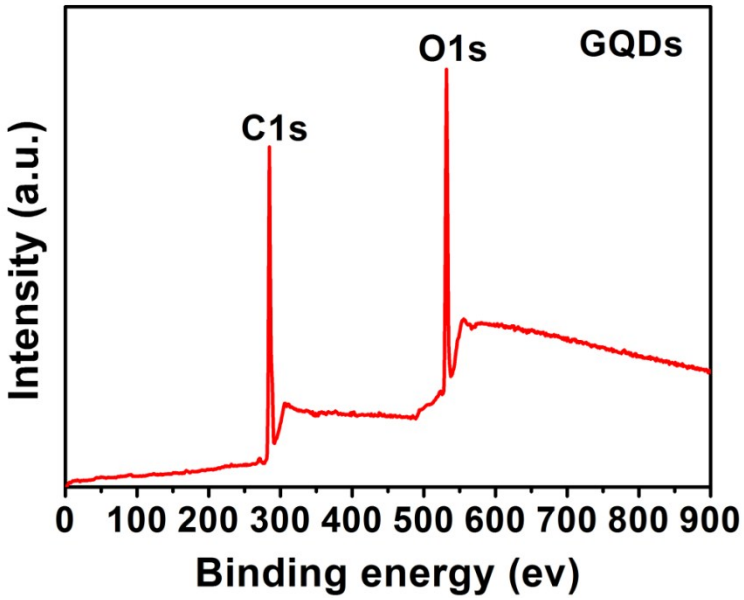

Figure. S6. The survey XPS spectrum of GQDs made from PBS electrolyte shows strong peaks of C1s at 284.5eV and O1s at 532.1eV, but does not exhibit peaks relevant to phosphors. This confirms that no phosphors were doped in the GQDs.

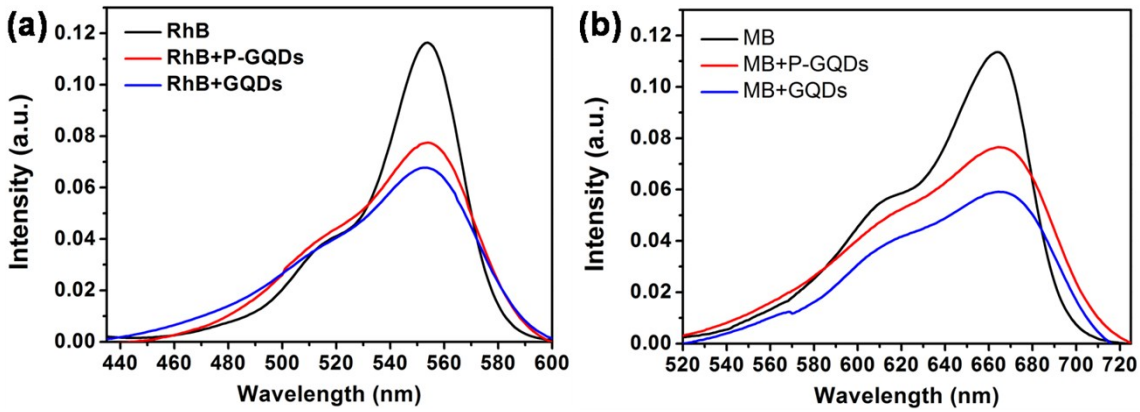

Figure. S7. The adsorption behavior of P-GQDs and GQDs was measured by RhB and MB, both two kinds of GQDs have the performance to absorb the organic matters, and the adsorption behaviour of GQDs is better than the P-

GQDs. According to the research of graphene, the adsorption behaviour of both GQDs are resulting from the electrostatic interaction and π-π stacking interaction, [39] the GQDs have a higher content of sp^2 structure, thus corresponded to a better performance of adsorption.

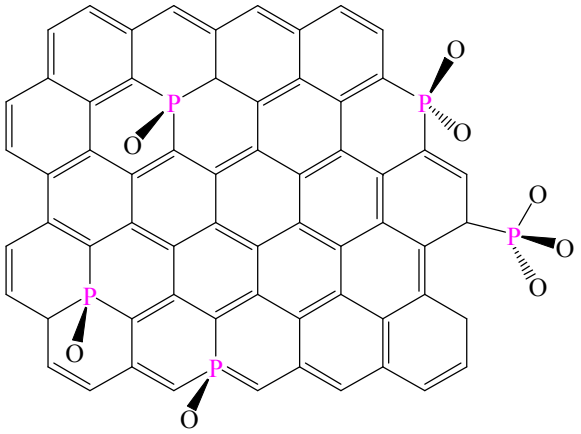

Figure. S8. The C_3PO, C_2PO_2 and CPO_3 structure of P-GQDs.

Table.S1 Comparison of Different kind of DPPH scavenger's highest scavenging efficiency.

DPPH Scavenger	DPPH's concentration (μmol/L)	The highest scavenging efficiency (%)	Ref
Fenugreek seeds	100	54	1
Fueoxanthin	100	40	2
Thioglycolic acid	50	80	3
Pinus maritima	60	94	4
CNTs	100	95.5	5
P-GQDs	63	79.7	This work

Table.S2 Comparison of the content of each element in GQDs and P-GQDs before and after reaction with DPPH.

Element Content（at%）	C	O	N	P
GQDs before	70.53	29.47	/	/
GQDs after	81.95	12.67	5.38	/
P-GQDs before	54.93	37.35	/	7.73
P-GQDs after	75.23	17.67	4.39	2.71

Notes and references

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