Supplementary Information

Fabrication of Poly (Quinine-co-Itaconic Acid) incorporated Reduced Graphene Oxide Nanocomposite and its Application for Electrochemical Sensing and Photocatalysis of Hydroquinone

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S1. EDX Analysis

Energy dispersive x-ray spectroscopy analysis was performed to determine the elemental composition of synthesized material. The EDX spectrum of GO is shown in figure S1(A) which shows two characteristic peaks i.e., carbon and oxygen with weight percentages of 70.16 % and 29.84 %, respectively. These results confirmed that GO has been successfully synthesized [1, 2]. The EDX spectrum of quinine Int. GO composite (figure S1B) shows similar peaks along with one new peak of nitrogen with weight percentage of 18.55 %. However, the weight percentage of oxygen is increased 38.06 % and the weight percentage of carbon is decreased to 43.39%. These results confirmed the intercalation of quinine into the layers of graphene oxide [3]. The EDX spectra of poly(quinine-co-itaconic acid)@GO composite (figure S1C) shows similar elements as quinine Int. GO; however, the weight percentage of oxygen is increase to 41.17 % due to copolymerization of itaconic acid with Quinine Int. GO [4].

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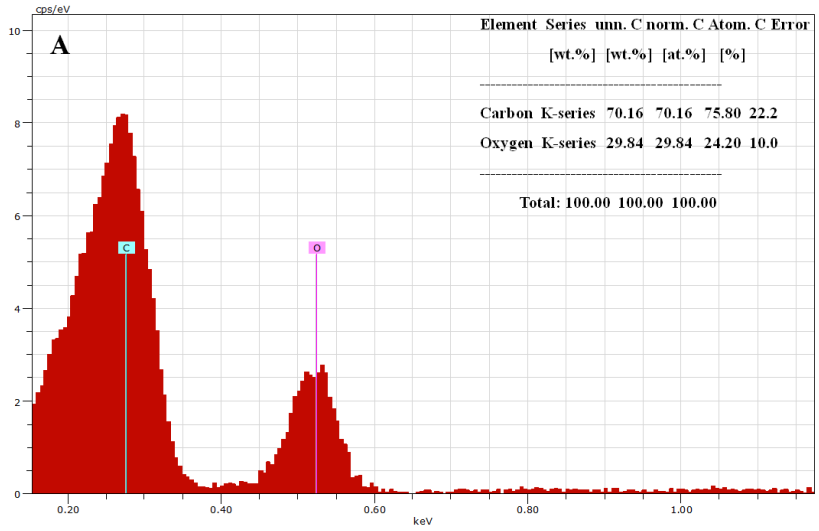
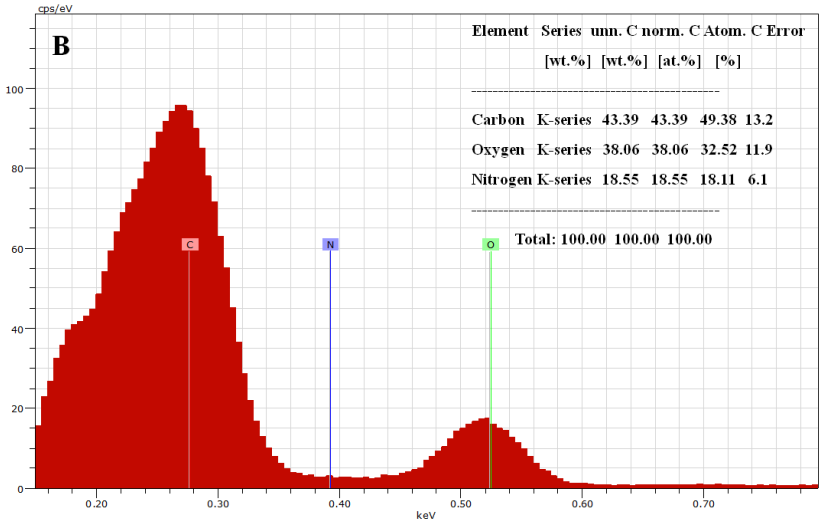

cps/eV
A
Element Series unn. C norm. C Atom. C Error
[wt.%] [wt.%] [at.%] [%]
Carbon K-series 70.16 70.16 75.80 22.2
Oxygen K-series 29.84 29.84 24.20 10.0
Total: 100.00 100.00 100.00
C
O
keV

24


cps/eV
B
Element Series unn. C norm. C Atom. C Error
[wt.%] [wt.%] [at.%] [%]
Carbon K-series 43.39 43.39 49.38 13.2
Oxygen K-series 38.06 38.06 32.52 11.9
Nitrogen K-series 18.55 18.55 18.11 6.1
Total: 100.00 100.00 100.00
C
N
O
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25

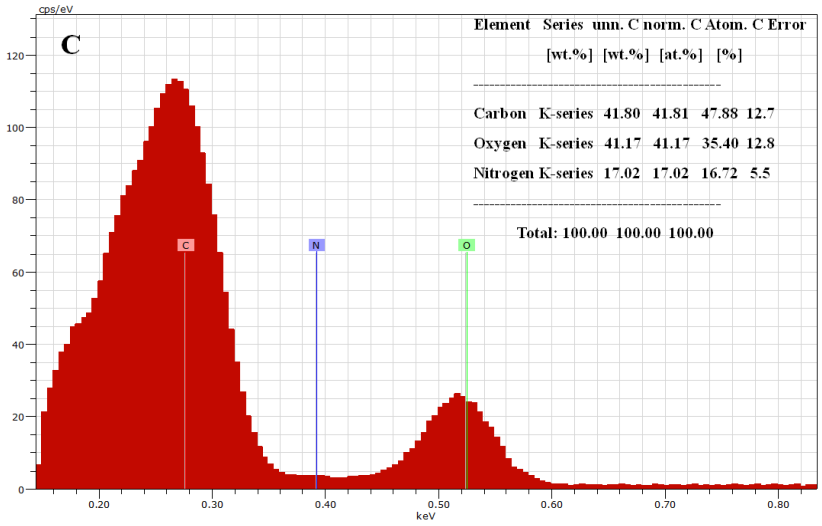
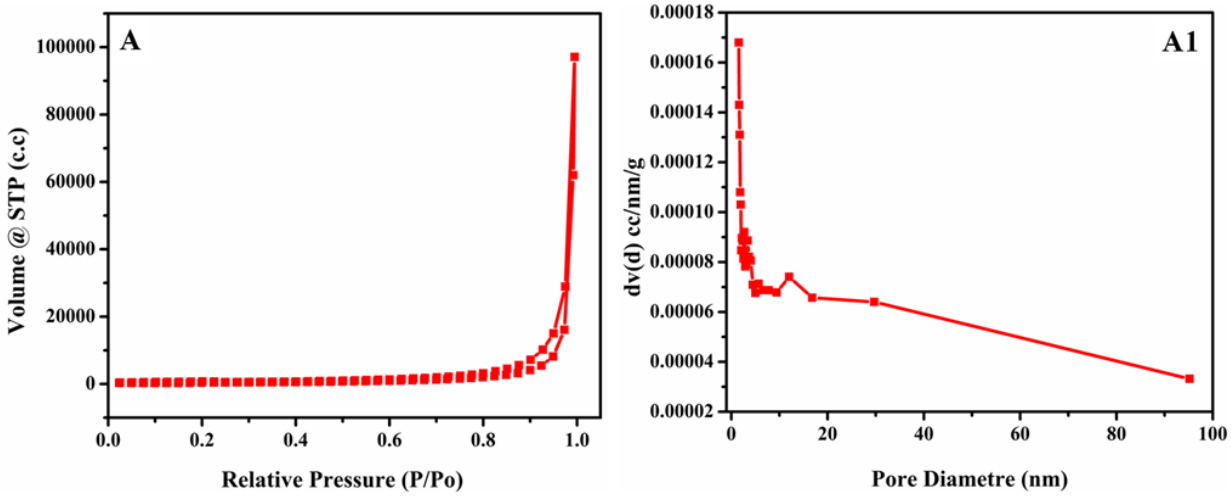


Figure S1: EDX spectra of (A) GO, (B) Quinine Int. GO composite and (C) Poly(quinine-co-itaconic acid)@rGO



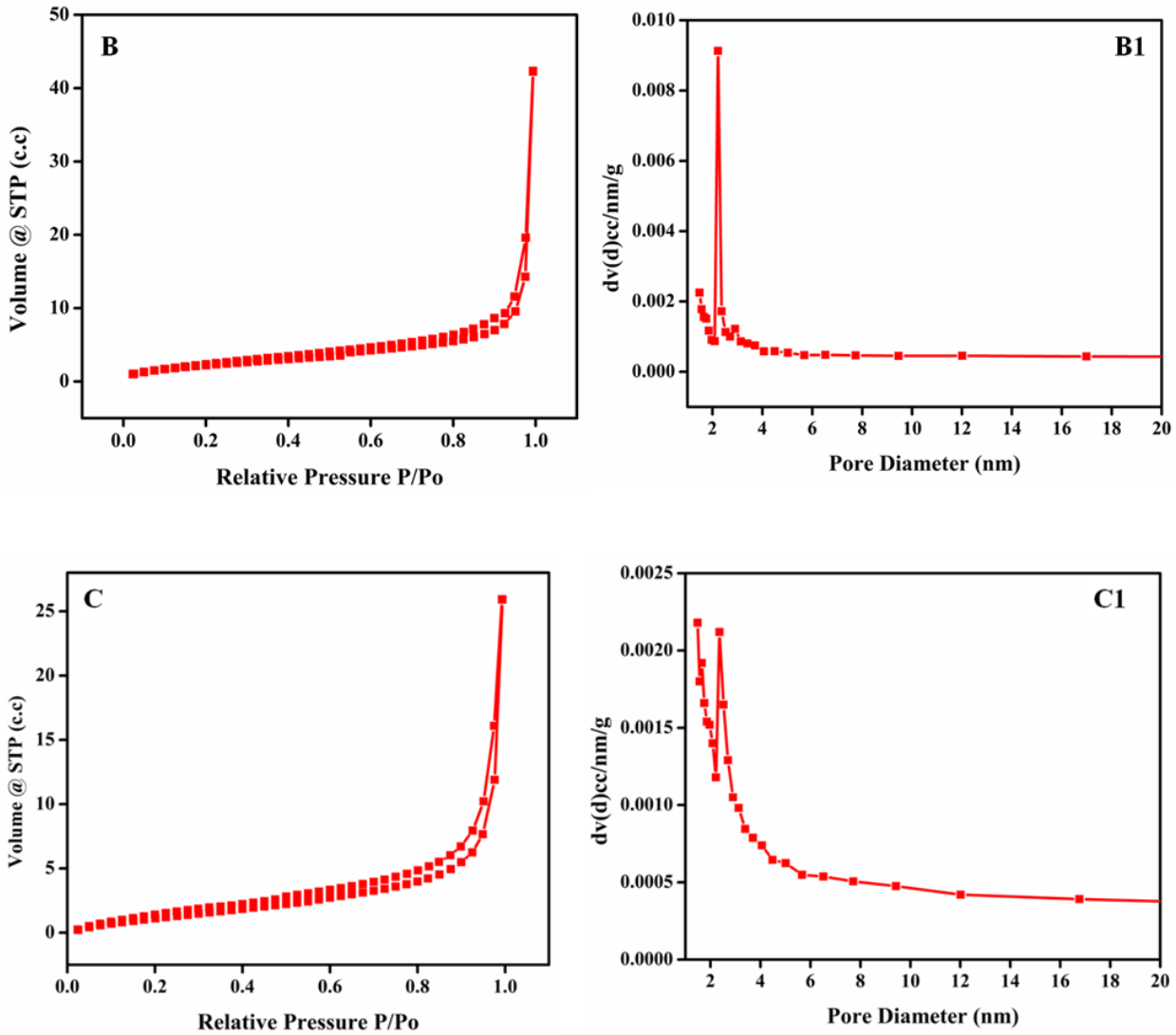


Figure S2: BET and BJH adsorption Isotherms of Graphene oxide (A, A1), Quinine Int. GO composite (B, B1), Poly(quinine-co-itaconic acid)@GO composite (C, C1)

S2. Surface Charge Analysis

The zeta potential was used to investigate the net surface charge of the material. The zeta potential charge distribution of GO i.e. -46.5 mV (figure S3A) due to oxygenated moieties of GO [5]. While, figure S3 (B) and (C) revealed the zeta potential of Quinine Int. GO composite and Poly(quinine-co-itaconic acid)@rGO composite is -27.0 mV and -17.6 mV. The material which has zeta potential value higher than ± 25 mV contains excellent material stability reported by Sztorch et. al.[6]. All composites have negative surface charge demonstrating that the materials are extremely robust and resistant to the agglomeration of sheets. Here, it is important to highlight

that the zeta potential of both Quinine Int. GO composite and Poly(quinine-co-itaconic acid)@rGO composite were increased due to the introduction of Quinine via intercalation and then copolymerization of Quinine Int. GO composite with itaconic acid [7].

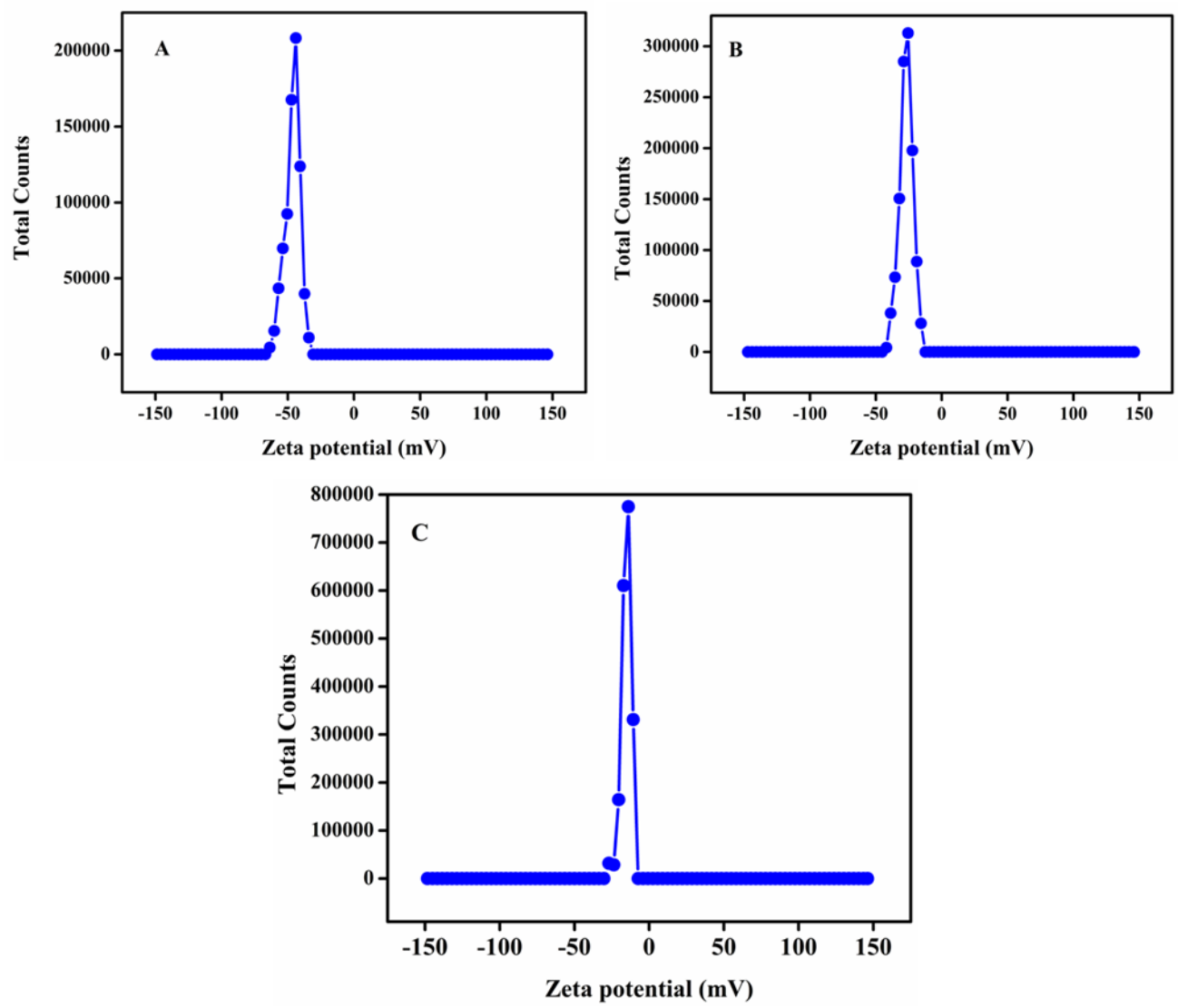


Figure S3: Zeta Potential of (A) GO (B) Quinine Int. GO composite (C) Poly(quinine-co-itaconic acid)@rGO composite

S3. Determination of energy bandgap

The band gap energy of the catalysts was examined by UV-Vis spectrophotometer (figure S4). To calculate the band gap of Poly(quinine-co-itaconic acid)@rGO composite the following equation was used.

$$Ebg = \frac{1240}{\lambda} \quad (2)$$

Where Eg represents band gap energy [8]. The graphene oxide band gap was 4.3 eV which is almost equal to the value given by zheng's works [9]. While the band gap of Quinine Int:GO was 4.8 eV and Poly(quinine-co-itaconic acid)@rGO composite was 4.1 eV. The slight decrease in band gap energy of poly(quinine-co-itaconic acid)@rGO composite due to the formation of sub-band level between valence band and conduction band formed due to coating of poly(quinine-co-itaconic acid) at the surface of GO [10]. The reduced band gap energy of poly(quinine-co-itaconic acid)@rGO composite indicates the improvement of photocatalytic activity as well as electrical conductivity due to fast electron transfer, which facilitates electrochemical sensing and photocatalytic degradation [11, 12].

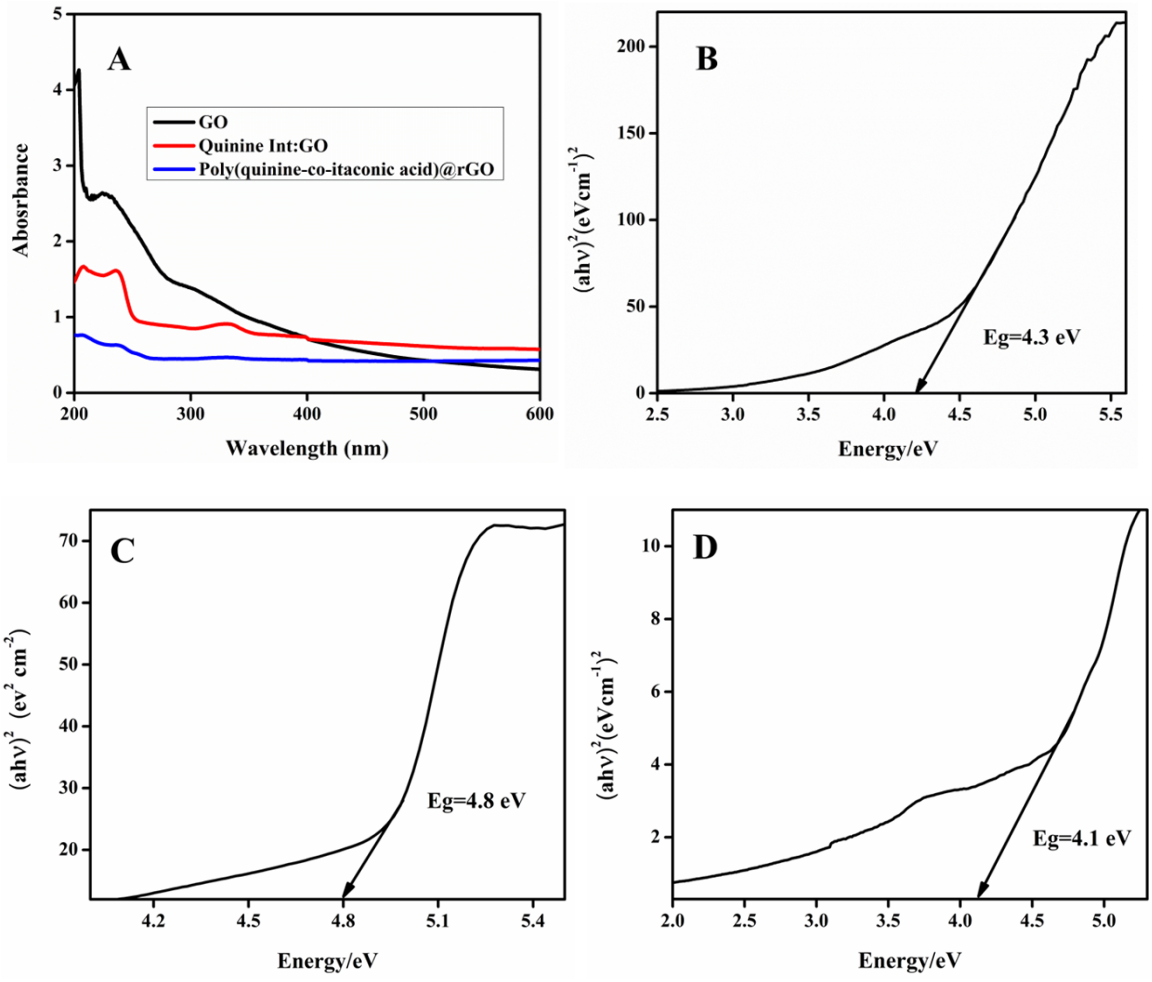


Figure S4: (A) UV-Vis spectra and (B,C,D) Tauc's plot of GO, Quinine Int. GO composite and Poly(quinine-co-itaconic acid)@rGO composite

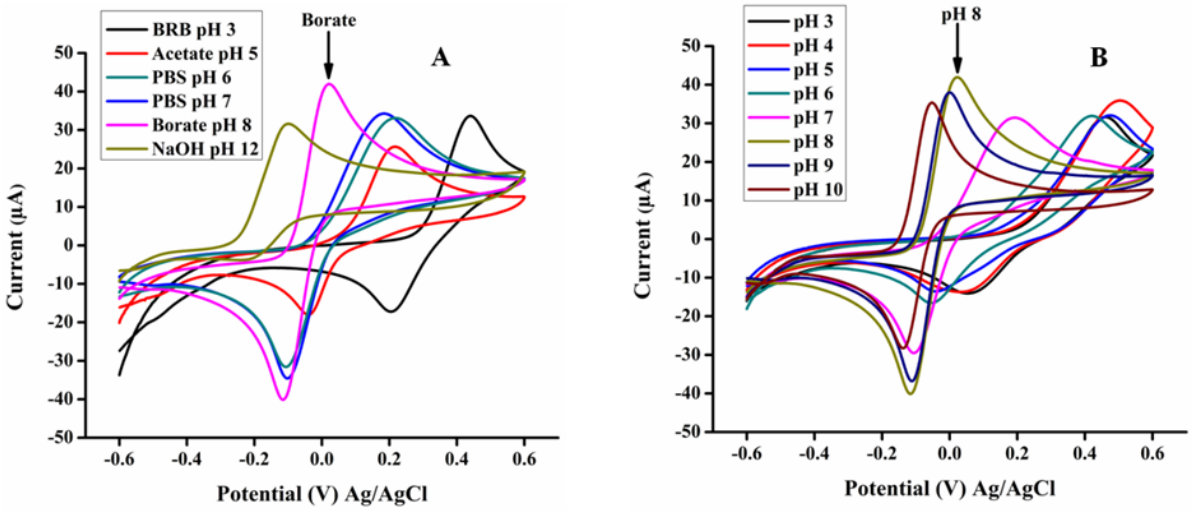


Figure S5: Figure 11 (A): CV redox response of HQ in various electrolytic medium and (B) pH study of 10 µM HQ at scan rate of 50 mV/s using Poly (quinine-co-itaconic acid)@rGO/GCE in borate buffer raging from pH 3 to 10.

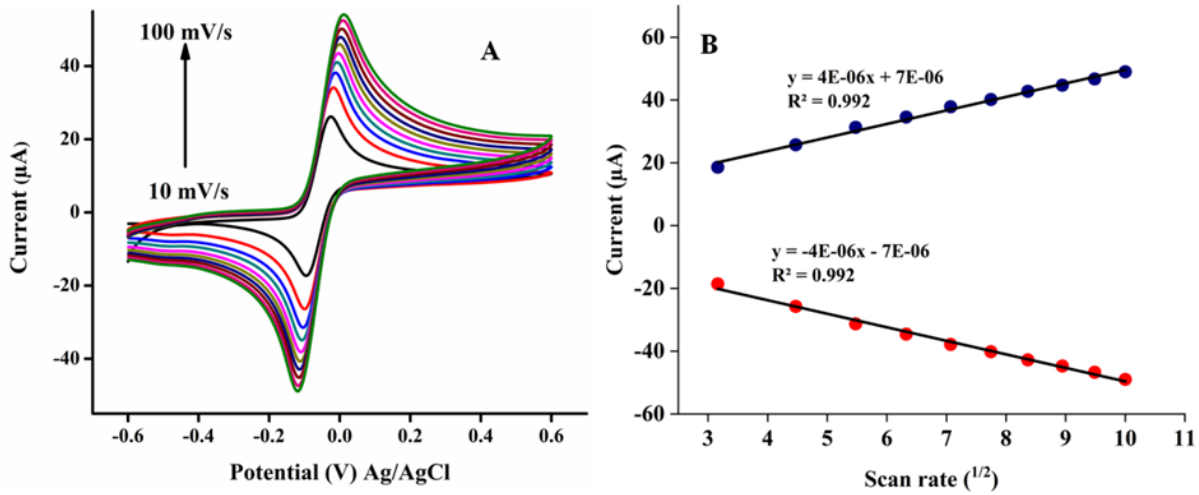


Figure S6: Effect of scan rate on redox peak current response of HQ, **(B)** plot of different scan rate from 10 to 100 mV/s with regression equation ($R^2 = 0.992$ for both anodic and cathodic peak current response).

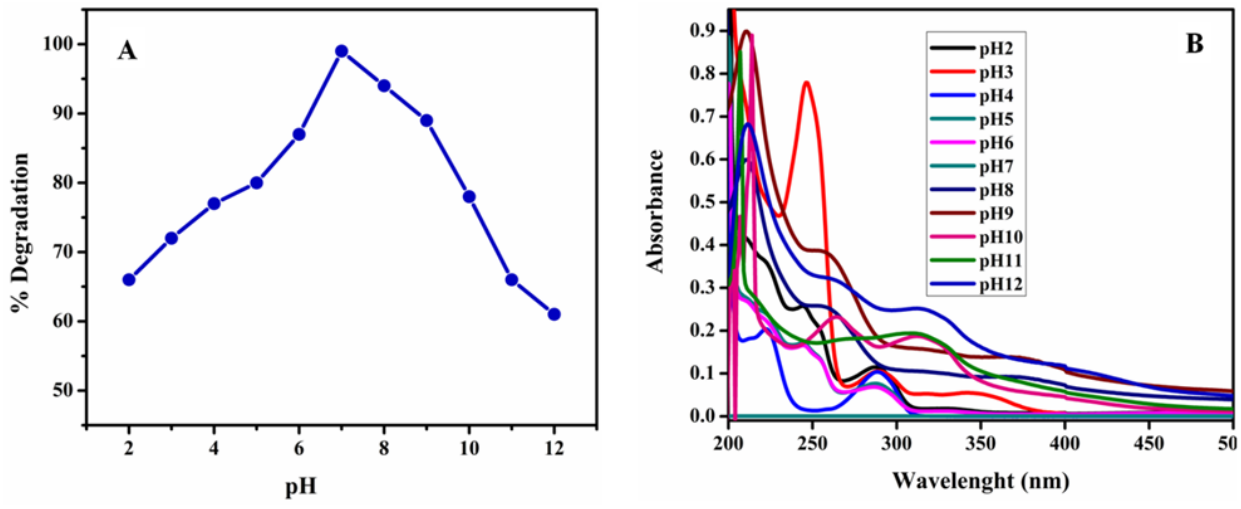


Figure S7: (A): % degradation of HQ at different pH and (B) UV-Vis spectra of photocatalytic degradation of HQ using Poly (quinine-co-itaconic acid)@rGO composite under UV-irradiation.

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