Supplementary Information (SI) for RSC Sustainability.
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Supplementary Information

Green synthesis of EuCN S-scheme photocatalysts via *Centella asiatica* extract for enhanced MB photodegradation and H_2O_2 photoproduction: DFT investigation and mechanistic insights

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S1. *Centella asiatica*

Figure S1: *Centella asiatica*

S2. Preparation of *Centella asiatica* extract

Figure S2: Extraction procedure of *C. asiatica* leaf extract

S3. Synthesis of graphitic carbon nitride

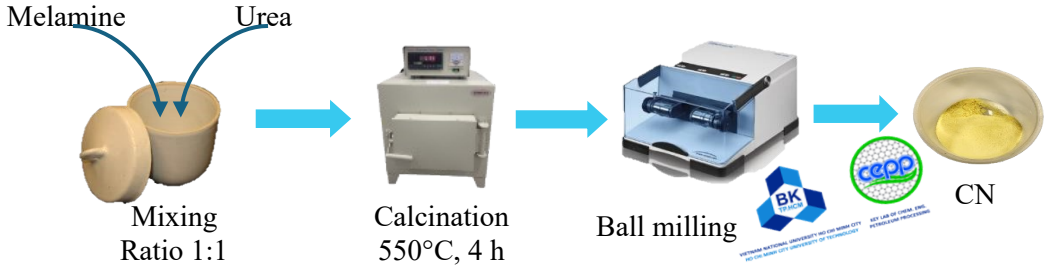


Figure S3: Preparation process of CN

S4. Green synthesis of europium oxide

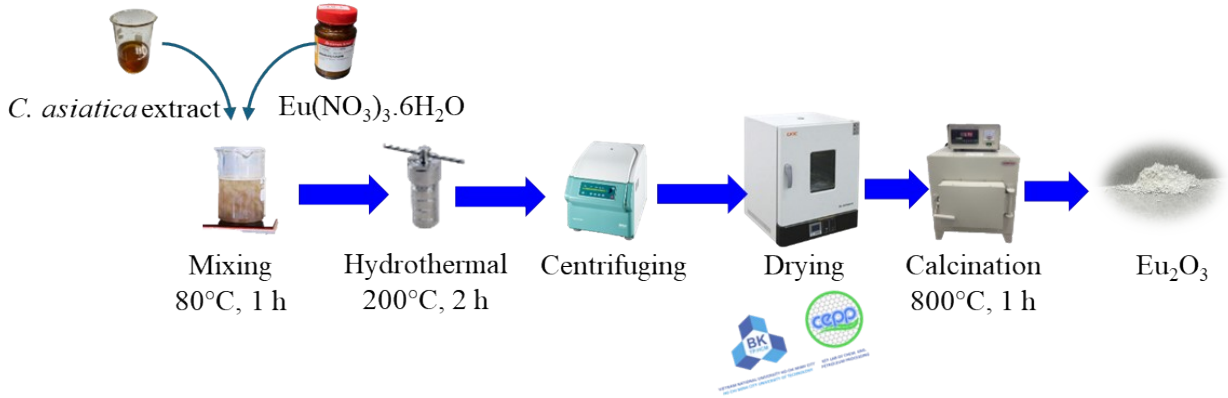


Figure S4: Green synthesis strategy for Eu_2O_3 nanoparticle

S5. Synthesis of europium oxide decorated on graphitic carbon nitride composite

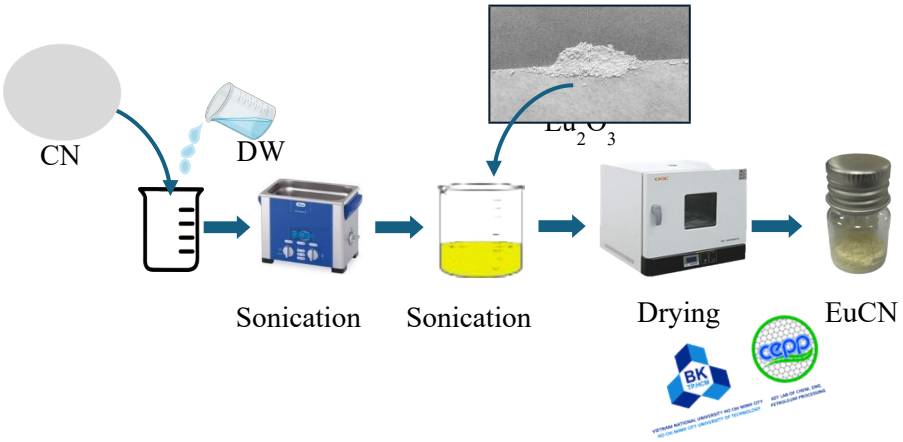


Figure S5: Synthesis procedure of EuCN composites

S6. HPLC measurement and results

S6.1. Chromatographic conditions

For flavonoids	For vitamin C
Chromatographic analysis was performed using an HPLC system equipped with a C18 column (250 mm × 4.6 mm, 5 µm) or an equivalent stationary phase. The detection wavelength was set at 370 nm. The mobile phase consisted of methanol-water-phosphoric acid (100:100:1, v/v/v). The flow rate was maintained at 1.5 mL/min, the column temperature was controlled at 30°C, and the injection volume was 20 µL. The mobile phase composition was adjusted when necessary to optimize peak separation.	Vitamin C (ascorbic acid) was analyzed using an HPLC system equipped with a C18 column (250 mm × 4.6 mm, 5 µm). Detection was performed using a UV detector set at 245 nm. The mobile phase consisted of a phosphate buffer solution adjusted to pH 2.5. The flow rate was maintained at 1.0 mL/min, and the injection volume was 20 µL. The phosphate buffer was prepared by dissolving 7.8 g of dibasic sodium phosphate and 6.1 g of monobasic potassium phosphate in water and diluting to 1000 mL. The pH was adjusted to 2.5 using phosphoric acid (H_3PO_4). The solution was filtered and degassed prior to use.

S6.2. Preparation of standard solution

For flavonoids	For vitamin C
A stock standard solution of isorhamnetin was prepared by accurately weighing approximately 20 mg of isorhamnetin into a 100 mL volumetric flask. Seventy milliliters of methanol were added, followed by sonication with intermittent shaking until complete dissolution. After cooling to room temperature, methanol was added to volume and the solution was mixed thoroughly. For the mixed standard solution, approximately 20 mg of quercetin and 20 mg of kaempferol were accurately weighed into a 100 mL volumetric flask. Sixty milliliters of methanol were added, and the mixture was sonicated with intermittent shaking until completely dissolved. After cooling, exactly 25.0 mL of the isorhamnetin stock solution was added, and the solution was diluted to volume with methanol. The final solution was filtered through a 0.45 μm membrane filter prior to injection.	Approximately 50 mg of ascorbic acid reference standard was accurately weighed and transferred into a 100 mL volumetric flask. About 50 mL of distilled water was added, and the solution was sonicated and shaken until complete dissolution. After cooling to room temperature, distilled water was added to volume and mixed thoroughly. The solution was filtered through a 0.45 μm membrane filter prior to injection.

S6.3. Preparation of sample solution

For flavonoids	For vitamin C
Approximately 0.5 g of *Centella asiatica* powdered sample was accurately weighed and extracted with 25 mL of distilled water. The extraction was performed by sonication at 40°C for 1 h. The extract was subsequently filtered through a 0.45 μm membrane filter to obtain the sample solution for HPLC analysis.	

S6.4. System suitability and analytical procedure

For flavonoids	For vitamin C

The standard solution was injected into the HPLC system, and chromatograms were recorded. System suitability was evaluated based on the following criteria: the relative standard deviation (RSD) of peak areas from six consecutive injections was required to be ≤ 2.0 %, and the peak symmetry factor was required to be ≤ 2.0. After the system met the suitability requirements, the sample solution was injected under the same chromatographic conditions, and chromatograms were recorded for quantitative analysis.

S6.5. Results

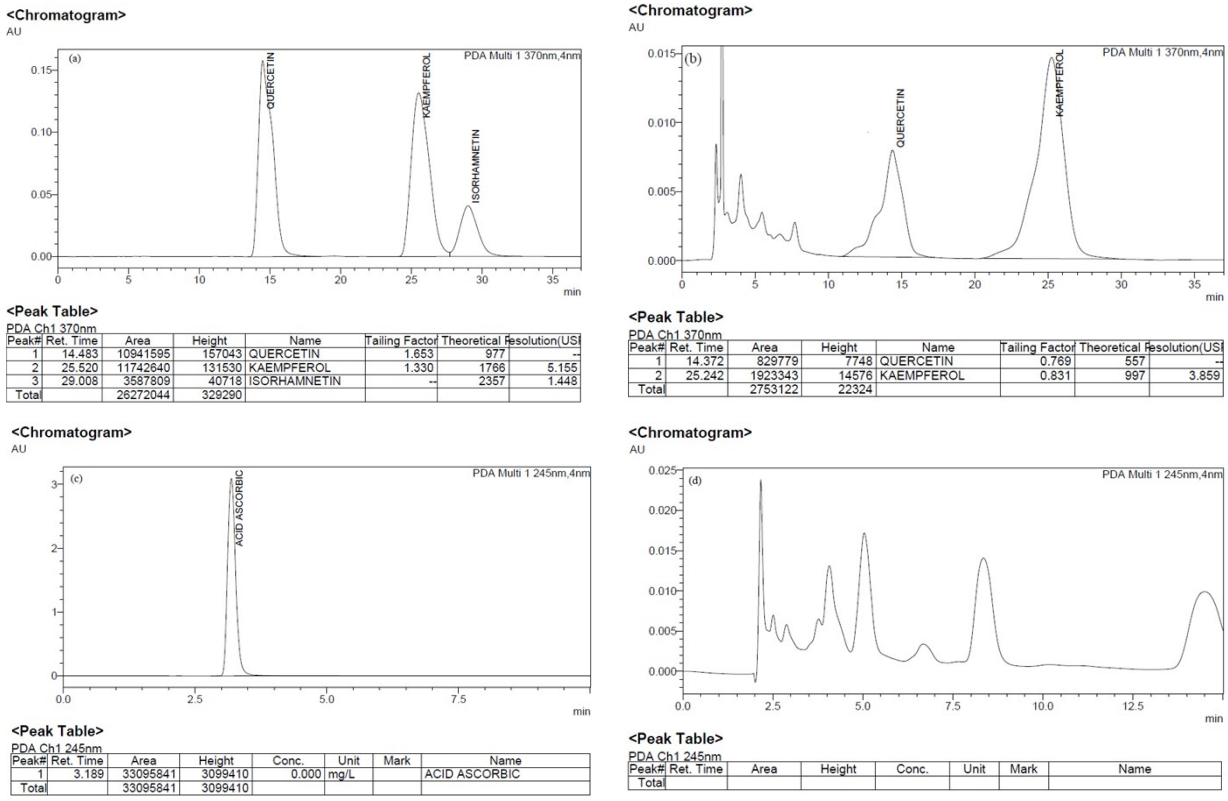


Figure S6: Representative HPLC chromatograms of the standard and sample solutions for polyphenols and vitamin C: (a) polyphenol standard, (b) polyphenol sample, (c) vitamin C standard, and (d) vitamin C sample

S7. H_2O_2 measurement

The calibration curve of H_2O_2 as shown in Figure S7.

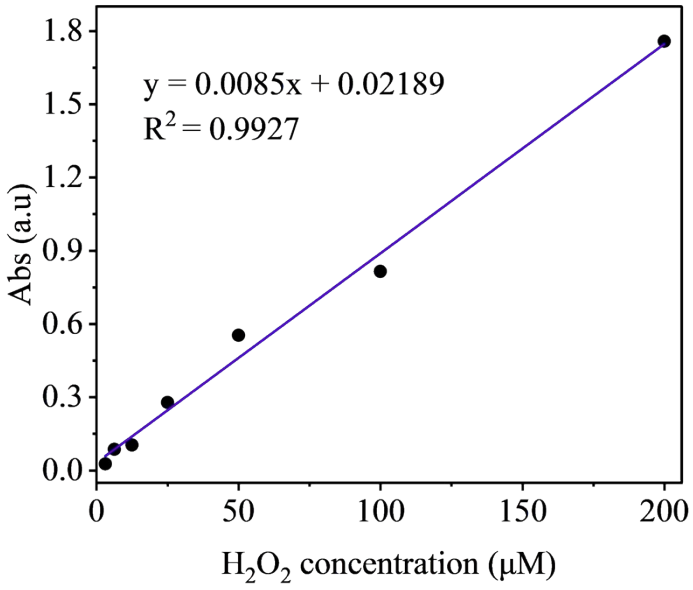


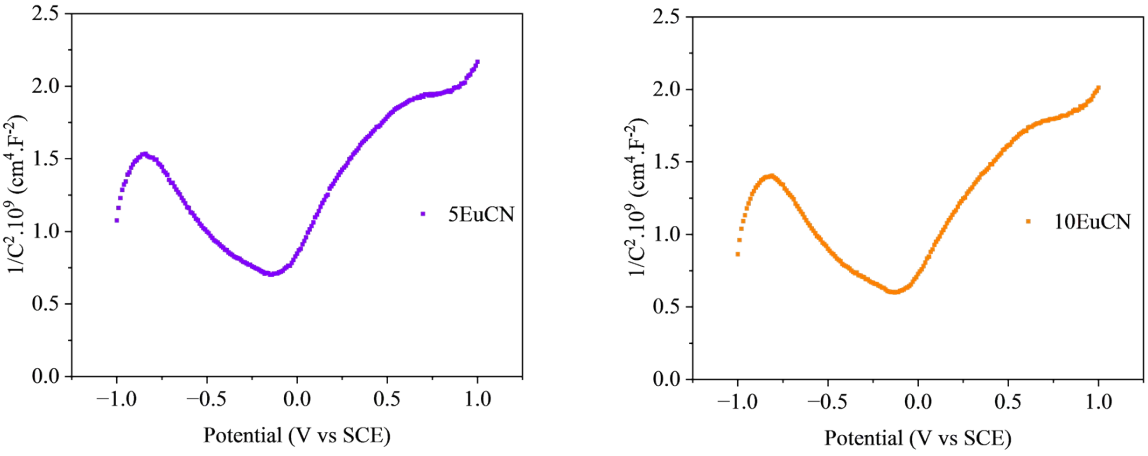
Figure S7: H_2O_2 calibration curve.

Based on Figure S7, the concentration of H_2O_2 was determined according to the following Equation (S1).

$$y = 0.0085x + 0.0219 \quad \text{(S1)}$$

where x is the H_2O_2 concentration (μM) and y is the absorbance (a.u), respectively.

S8. Mott-Schottky curves



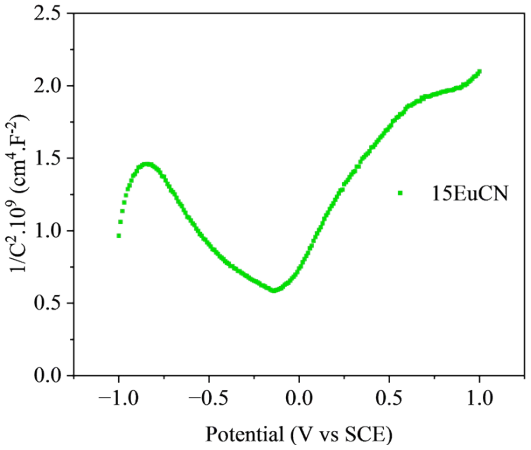


Figure S8: Mott-Schottky curves of (a) 5EuCN, (b) 10EuCN, and (c) 15EuCN composite

S9. DFT calculation

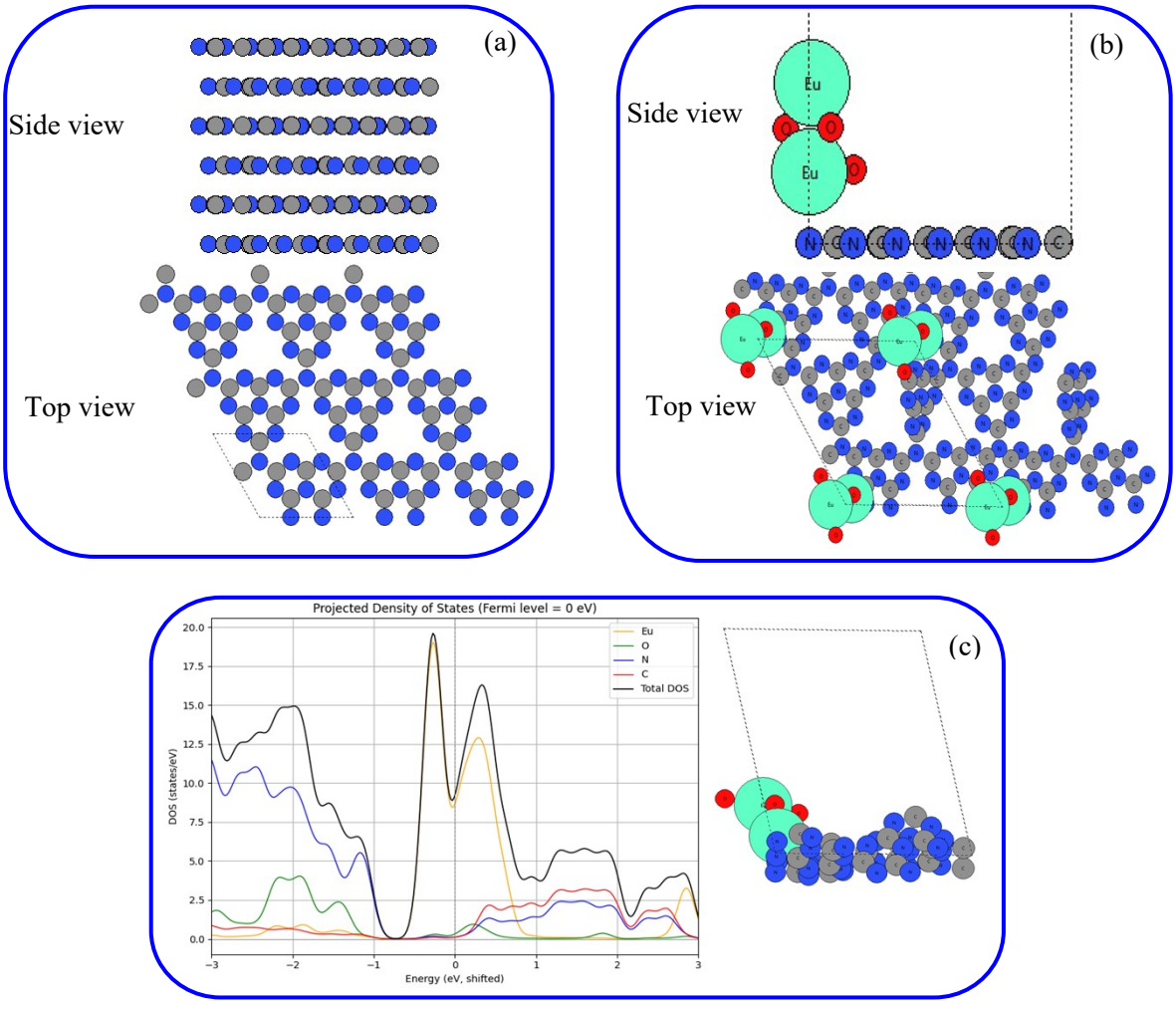


Figure S9: Building structure for (a) CN and (b) EuCN; (c) total DOS of EuCN composite