Electronic Supplementary Material (ESI) for Green Chemistry.

An eco-friendly biomass pretreatment strategy utilizing reusable enzyme mimicking nanoparticles for lignin depolymerization and biofuel production

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Supporting Information

S1: Synthesis of nanoparticles

Synthesis of CeONP

Experiment was carried out according to the previous research with silght modification.[1,2] Chitosan (0.5 g) was added in 3% (w/v) acetic acid solution and dissolved completely. Afterwards, 1 g cerium nitrate hexahydrate was mixed with the chitosan-acetic acid solution for 1 h. Stoichiometric amount of H_2O_2 was added dropwise to the solution and mixed thoroughly until the color turned from colorless to orange. Subsequently, the final solution was centrifuged at 15000 rpm for 30 min, followed by three times washing with water and ethanol. Finally, the recovered nanoparticles were freeze-dried and stored for further use.

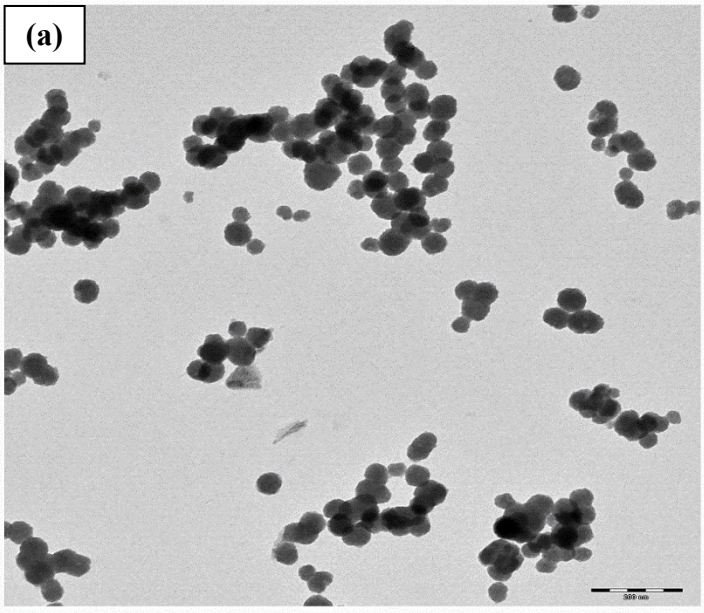
Synthesis of FeONP

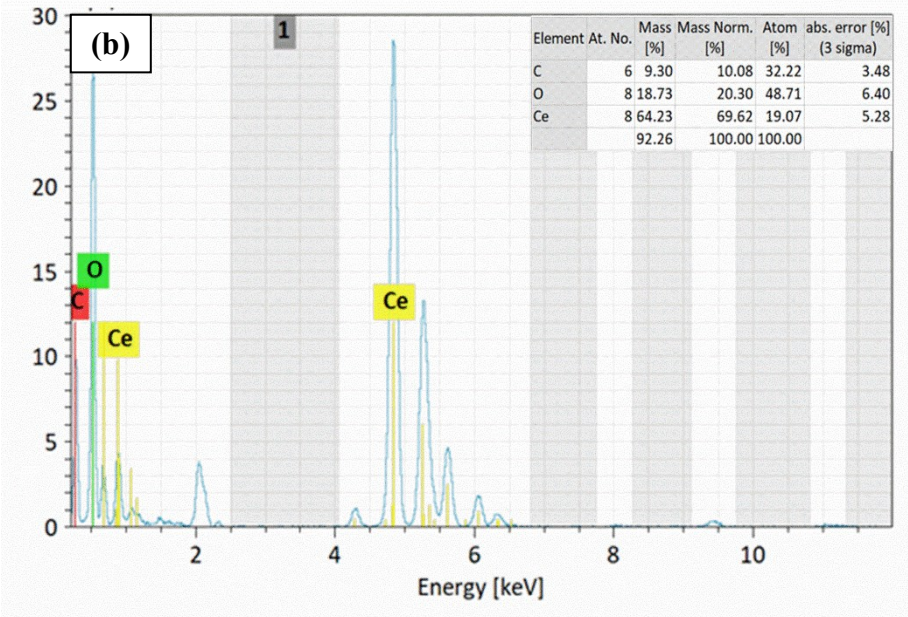
FeONP was synthesized as reported previously with slight modification.[2] Ammonia was added at 1:1 (v/v) ratio to distilled water along with 1 M $FeCl_2$ and 2 M $FeCl_3$, followed by stirring at 60 °C overnight. The formed nanoparticles were washed with distilled water, followed by freeze drying.

Synthesis of Ce-FeONP

Ce-FeONP was obtained according to the previous study.[3] $FeCl_2$ and $FeCl_3$ were taken as 1:2 molar ratio in distilled water and mixed with ammonia solution (1:1, v/v) at 60 °C for 1 h. Subsequently, 5 wt% of cerium nitrate hexahydrate (against the wetight of $FeCl_3$ and $FeCl_2$) was added to the solution and further mixed overnight. The formed nanoparticles were centrifuged at 15000 rpm for 30 min followed by washing with water and ethanol three times. Finally, the recovered nanoparticles were freeze-dried and stored for further use.

Supplementary Figures





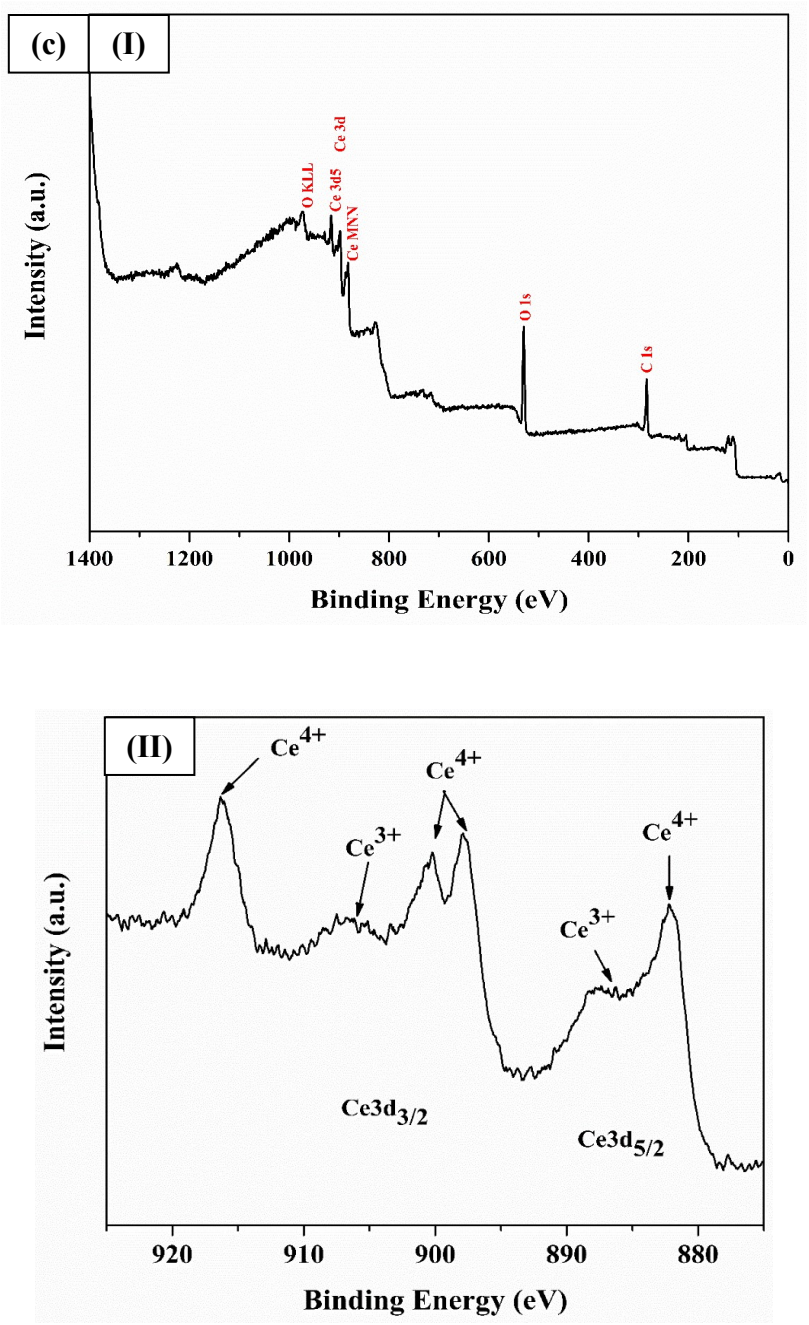


Fig. S1. (a) TEM images and (b) elemental compositional profile of synthesized CeONP, (c) XPS spectra: (I) survey of CeONP, (II) Ce3d XPS spetra of CeONP.

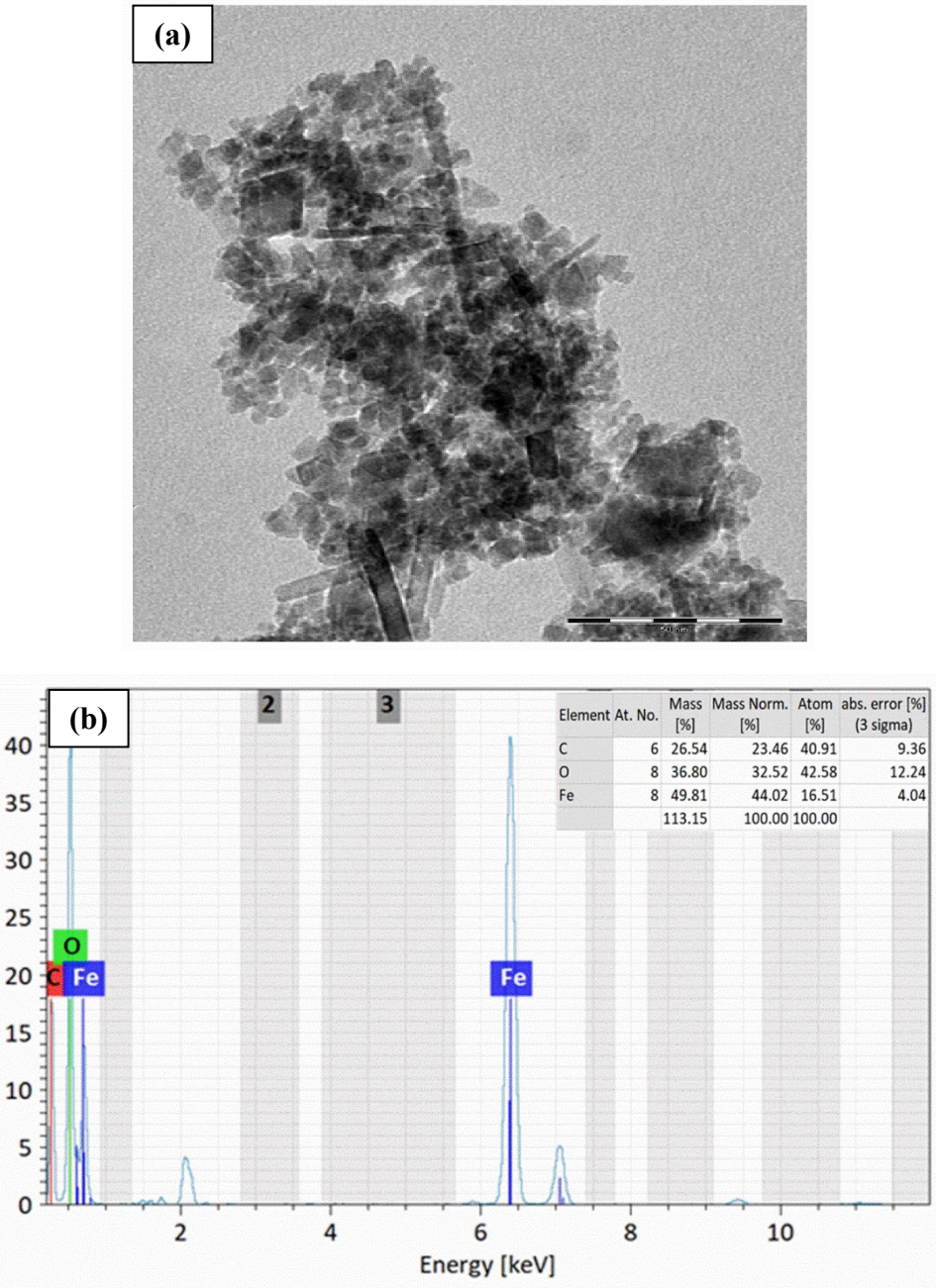


Fig. S2. (a) TEM image and (b) elemental composition of synthesized FeONP.

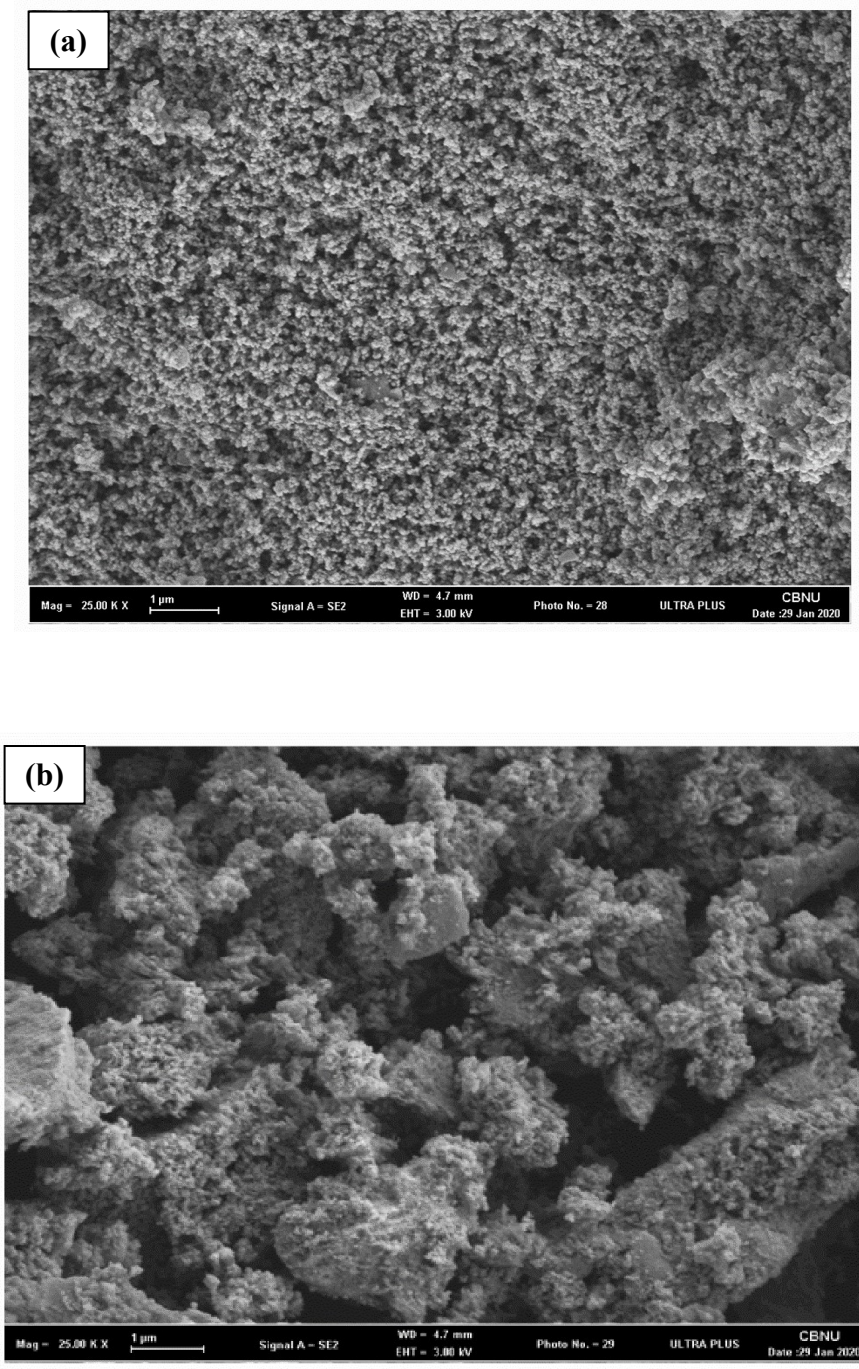
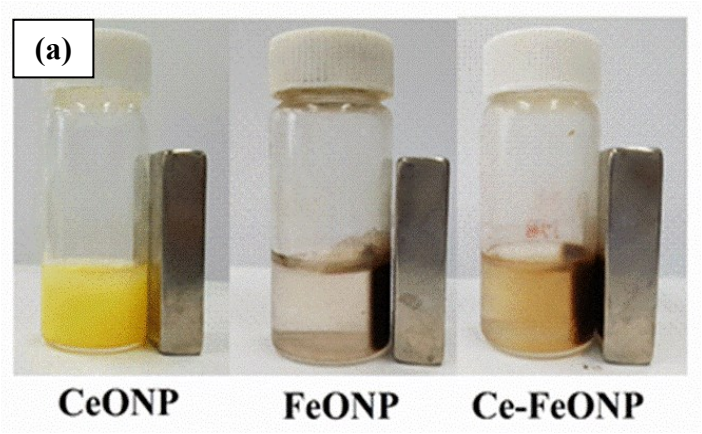
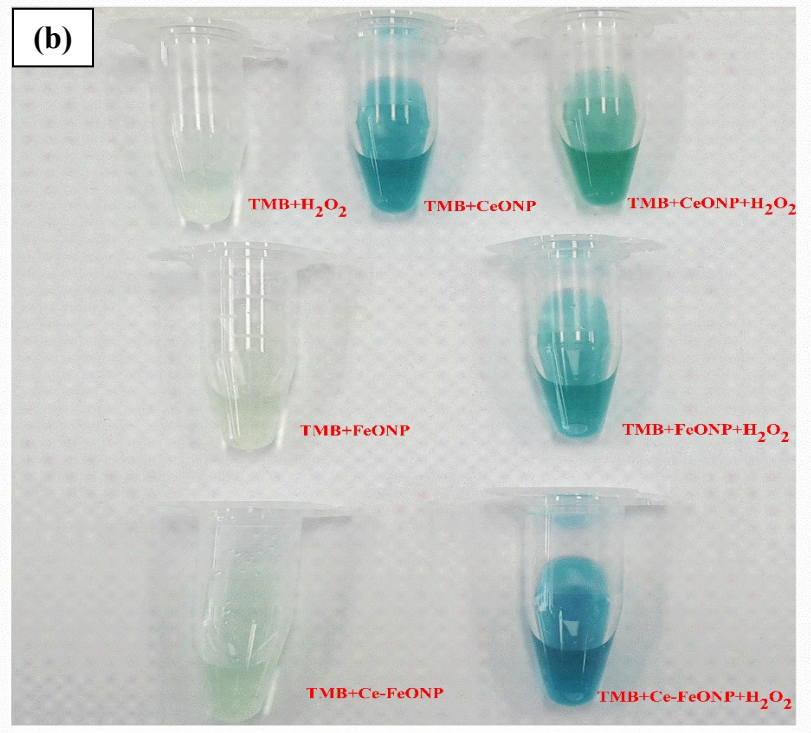


Fig. S3. Morphological images of synthesized (a) CeONP and (b) FeONP.


(a)
CeONP
FeONP
Ce-FeONP


(b)
TMB+H2O2
TMB+CeONP
TMB+CeONP+H2O2
TMB+FeONP
TMB+FeONP+H2O2
TMB+Ce-FeONP
TMB+Ce-FeONP+H2O2

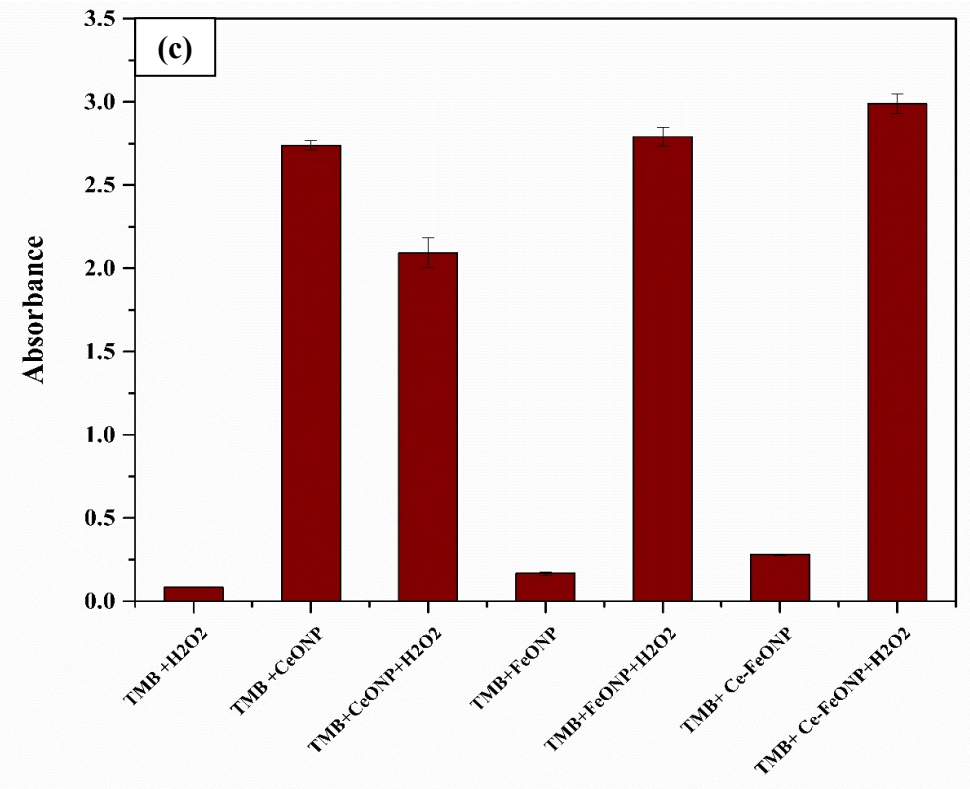


Fig. S4. (a) Magnetic property of synthesized CeONP, FeONP, and Ce-FeONP, (b) and (c) peroxidase assay of synthesized nanoparticles.

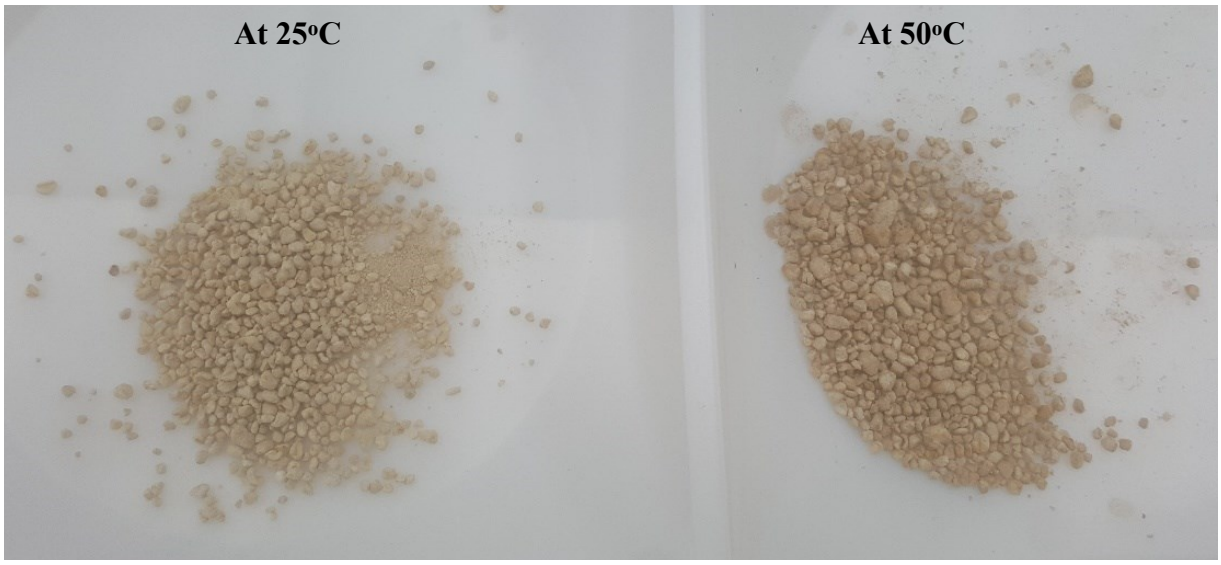


Fig. S5. Treated biomass after first washing at 25 ºC and 50 ºC.

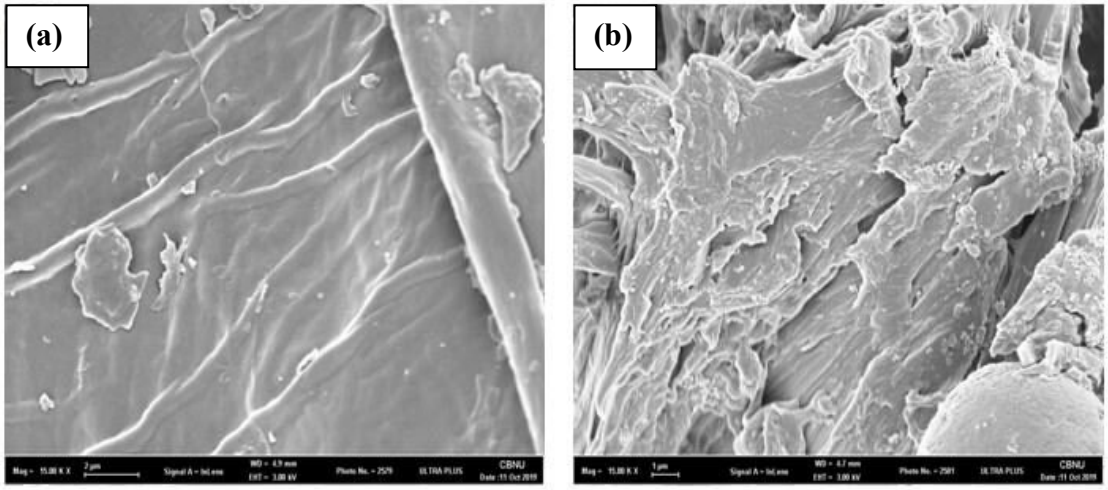


Fig. S6. SEM images of (a) raw and (b) pretreated corn cob biomass.

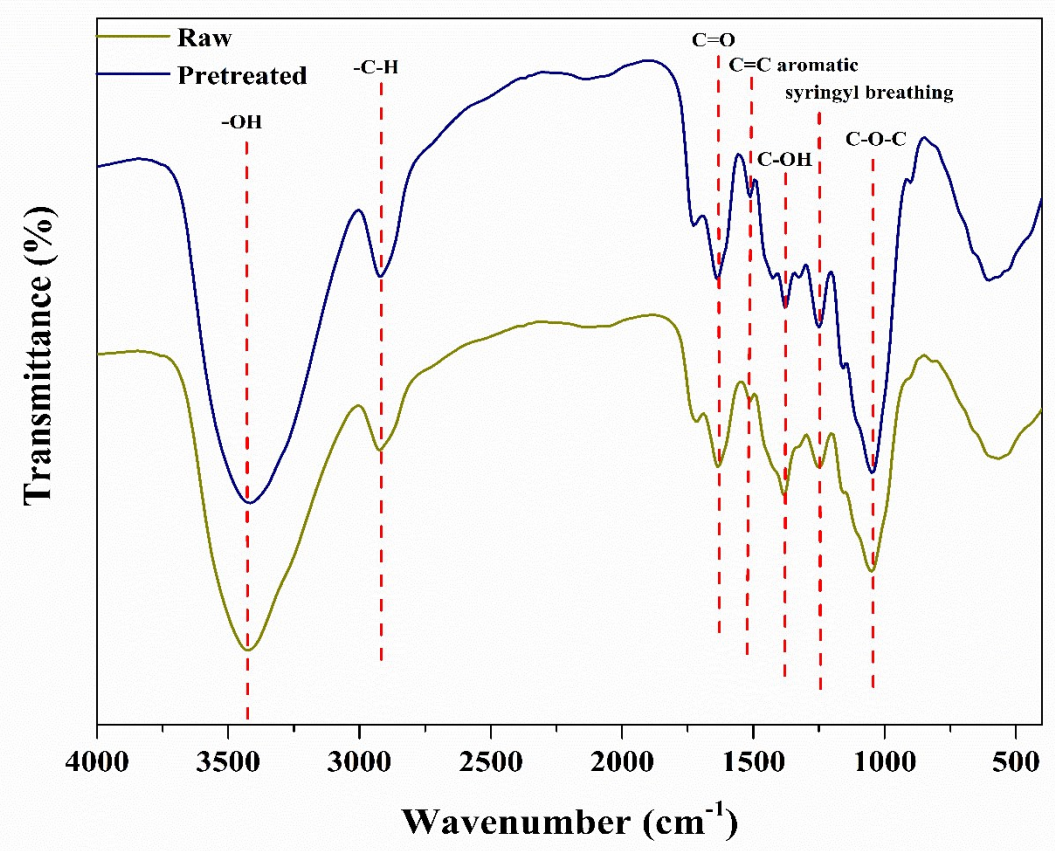


Fig. S7. FTIR spectra of raw and pretreated corn cob biomass.

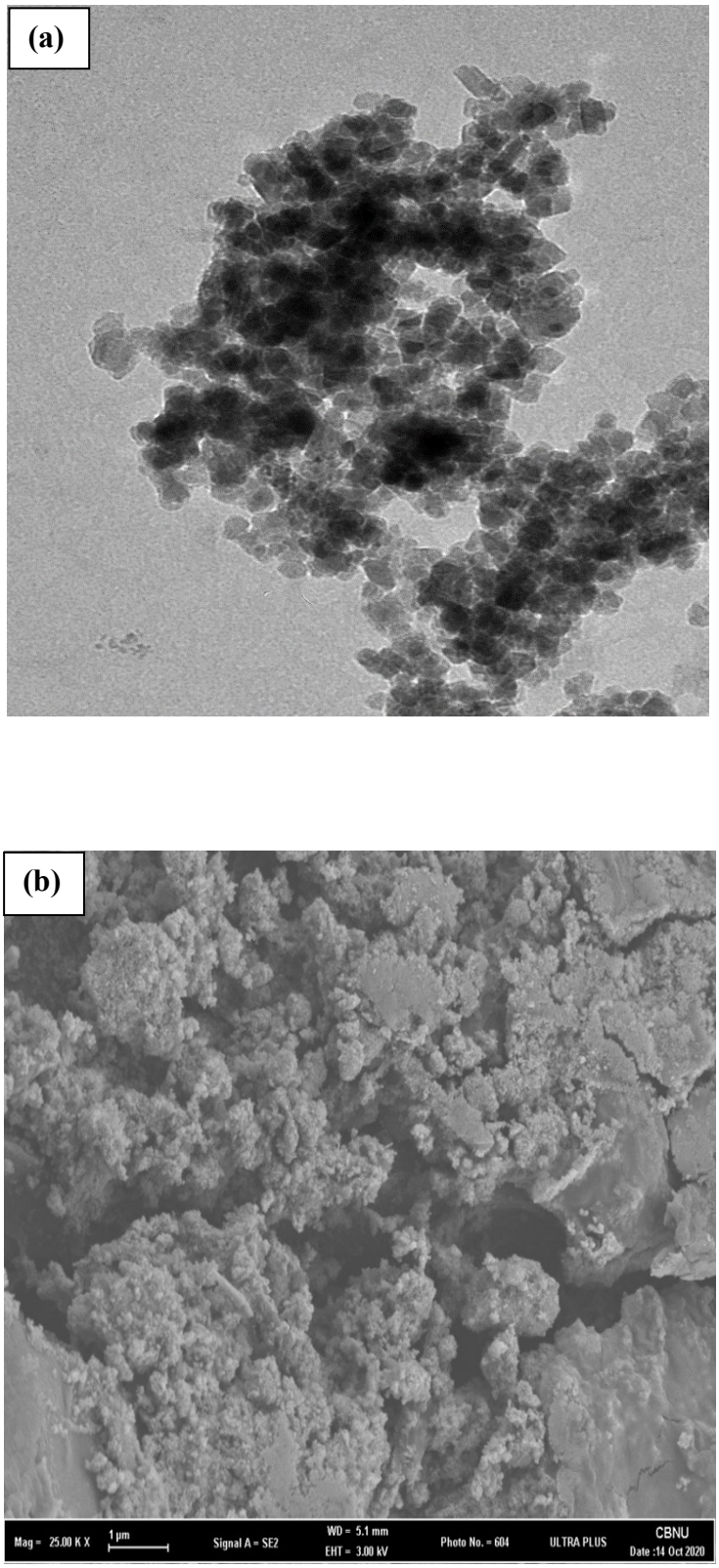


Fig. S8. (a) TEM and (b) SEM images of recovered Ce-FeONP.

References

1. A. Kaushik, P. R. Solanki, M. K. Pandey, S. Ahmad and B. D. Malhotra, *Appl. Phys. Lett., 2*009, **95**, 173703.
2. P. Saha, A. Maharjan, P. K. Dikshit and B. S. Kim, *Korean J. Chem. Eng.,* 2019, **36**, 2143-2152.
3. Aashima, S. Uppal, A. Arora, S. Gautam, S. Singh, R. J. Choudhury and S. K. Mehta, *RSC Adv*., 2019, **9**, 23129.