

Kinetics Studies of the Degradation of Methylene Blue and Rifampicin Using Green Synthesized Iron Nanoparticles

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Aim: To determine the kinetics of degradation of methylene blue and rifampicin using biosynthesized iron nanoparticles using selected plants.

Introduction/Background

Access to safe, high-quality water in developing countries is a challenge due to microbial, organic, and inorganic pollutants [1]. Pharmaceuticals, including pathogens, dyes, and heavy metals, pose a major global concern due to potential health and environmental issues [2]. In Kenya, residents are suffering from health complications due to contaminated water. Green synthesis and characterization of iron nanoparticles (NPs) using *Bidens pilosa* (L.) leaves (3) and study of the kinetics of degradation of Methylene blue dye and Rifampicin antibiotic are herein reported.

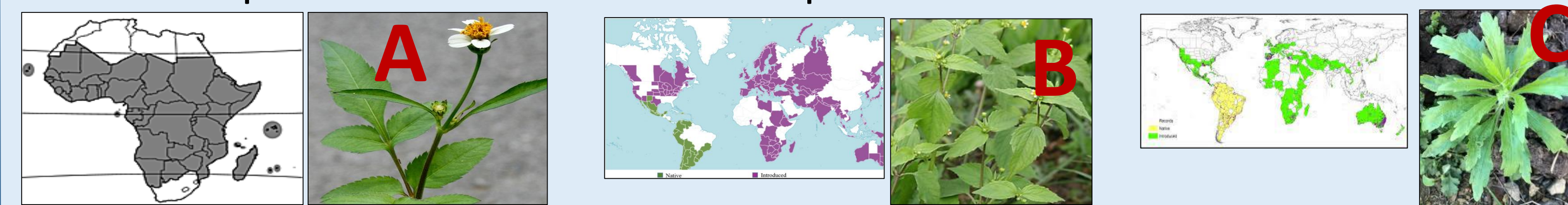


Figure 1: (A) *Bidens pilosa*, (B) *Galinsoga parviflora*, & (C) *Conyza bonariensis* distribution

General Uses: Vegetables, Treatment of malaria, flu, cold, colorectal cancer, liver problems, inflammation, Antibacterial, Antidysenteric, inflammatory, analgesic, dermatological disorders; eczema, lichen, and non-healing and/or bleeding wounds.

Materials and Methods

Bidens pilosa, *Galinsoga parviflora*, & *Conyza bonariensis* leaves, iron III chloride, methanol, rutin, Folin-Ceucalteu reagent, acetone, KBr, distilled H₂O, Na₂CO₃, NaOH, Gallic acid,

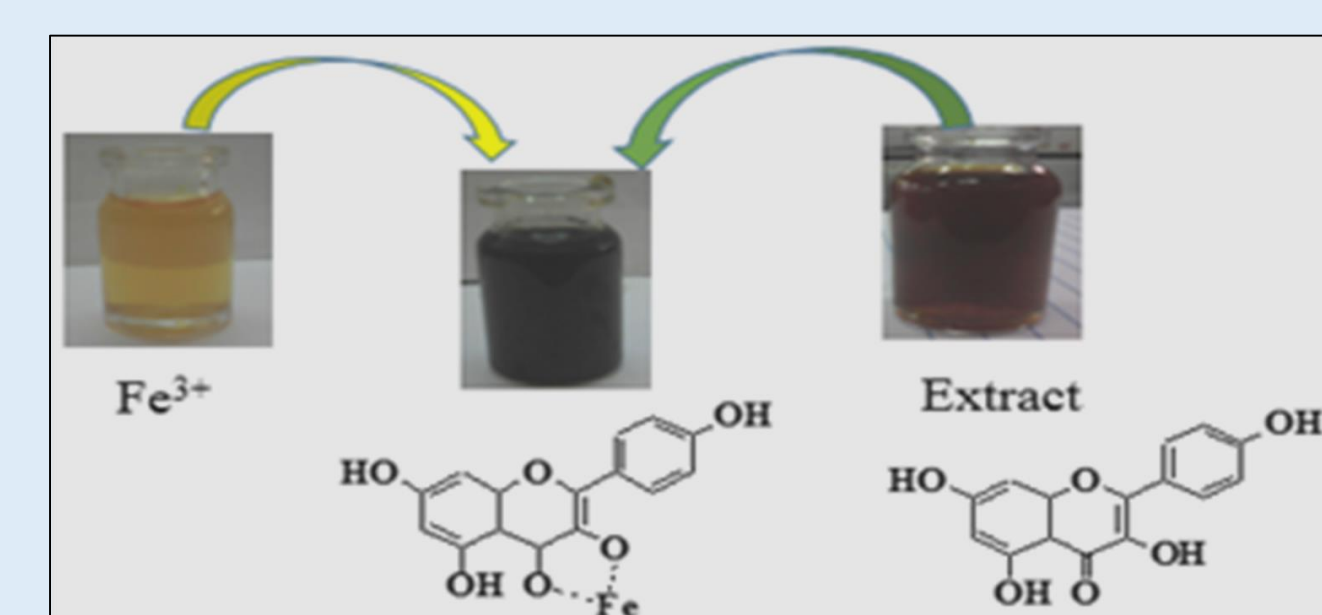


Figure 2: Mechanism of Synthesis

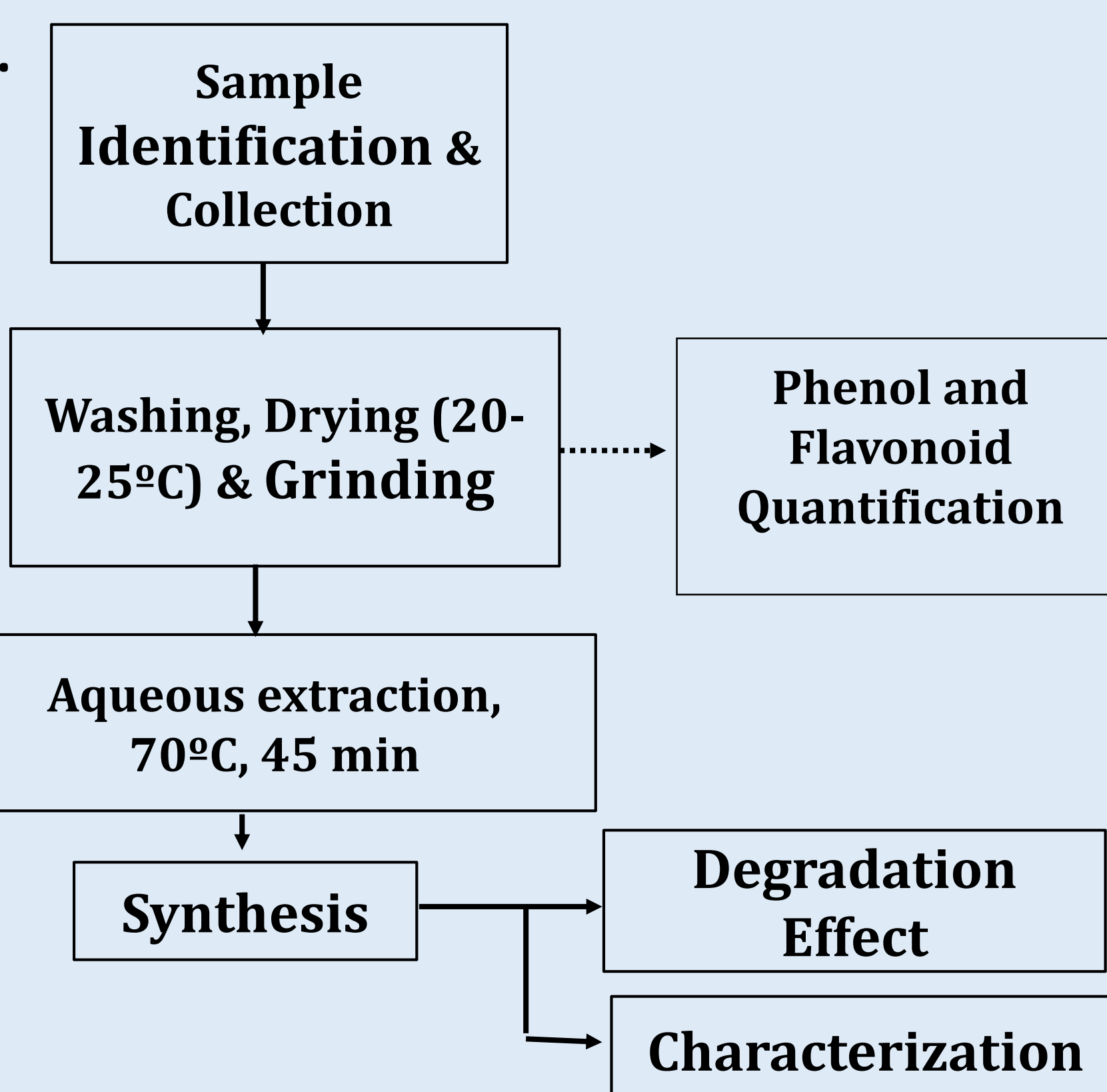


Table 1: Outline of Methodology

Instrumentation

Shimadzu, UV1800
UV Vis



Shimadzu,
FTS8000 FTIR



STOE STADIP P,
XRD

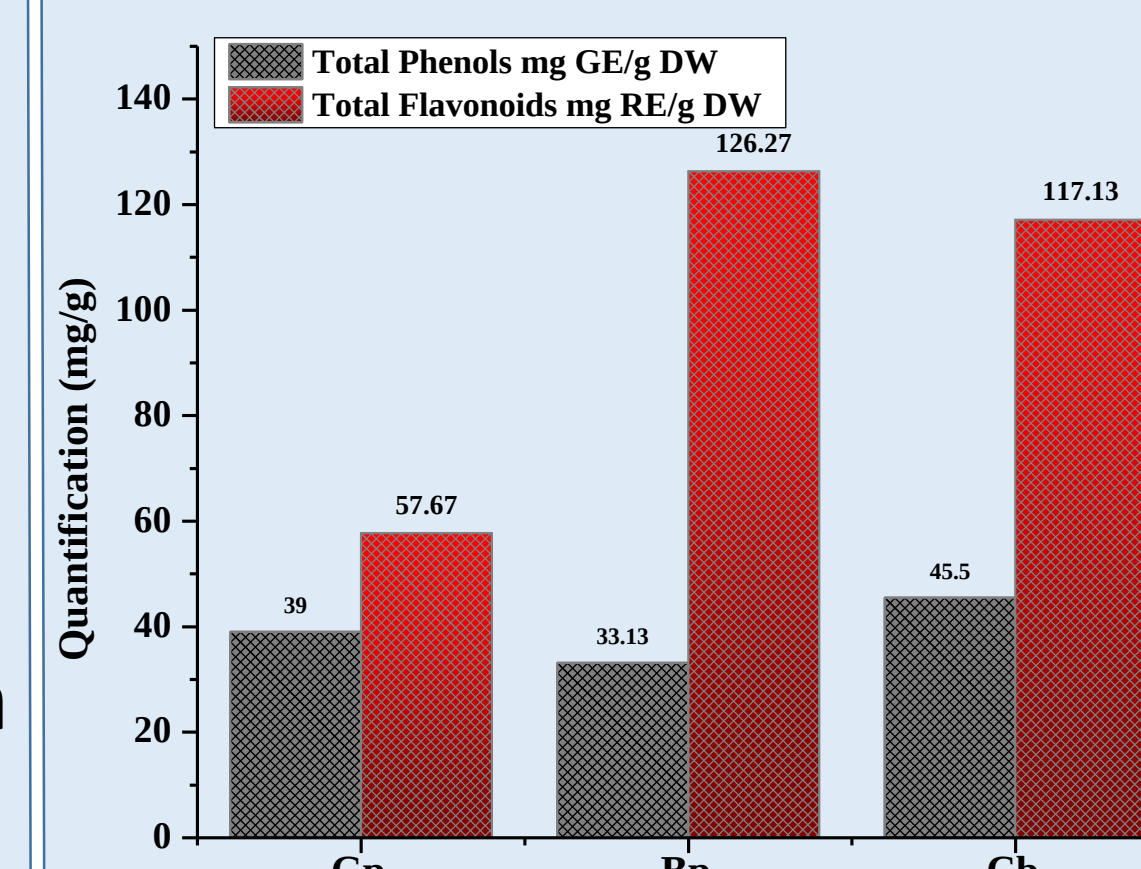


Tescan Mira3 LM
FE SEM



Results

Total Flavonoid & Polyphenol Content of extract was determined using Aluminium chloride & Folin-Ciocalteau method and NPs characterized using UV Vis, FTIR, XRD, & SEM



The total phenol content was found higher in all samples. The compounds provide electrons that reduce the ions to NPs

Figure 3: Total Flavonoids & Polyphenols
UV - Vis

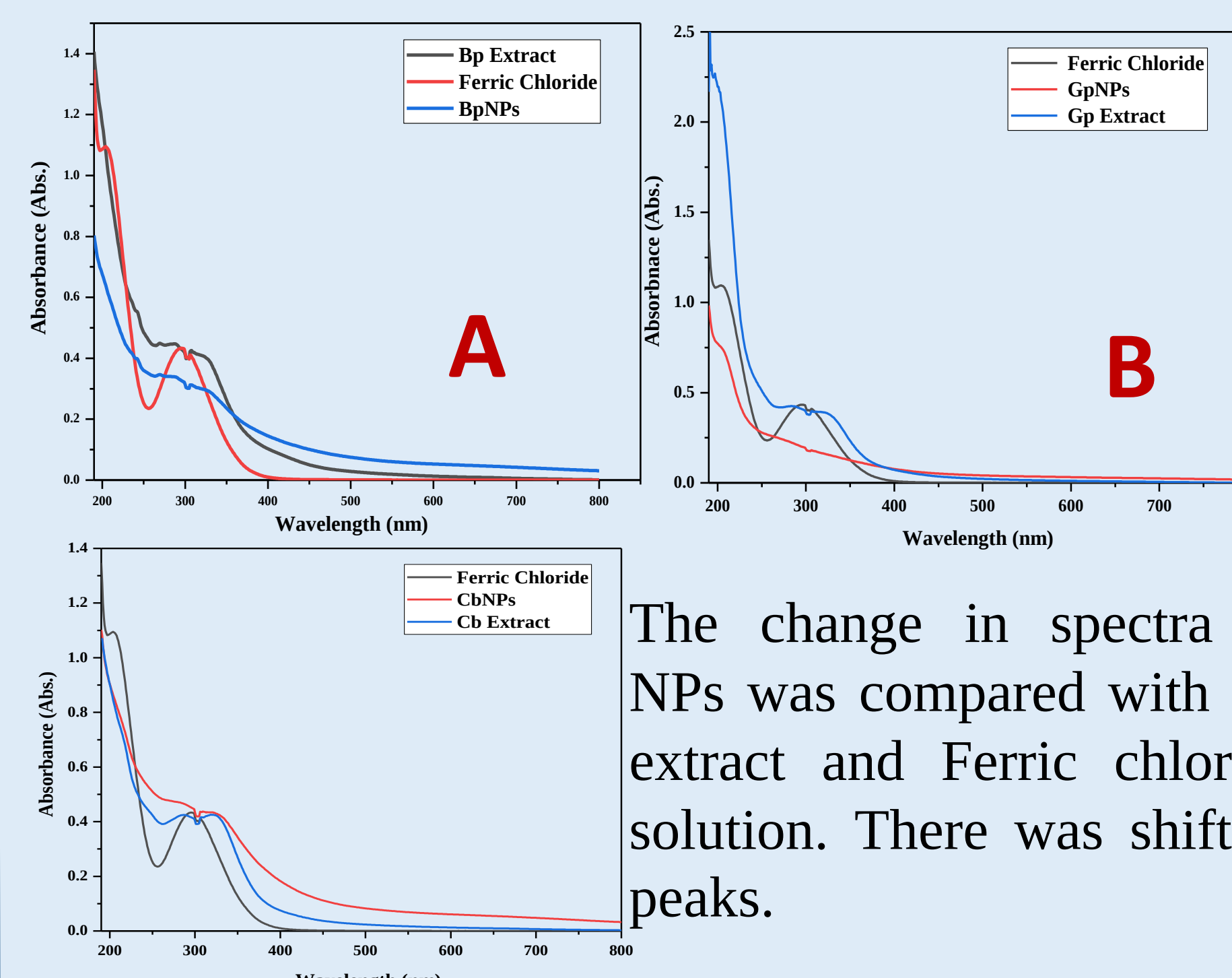


Figure 4: *Bidens pilosa* (A), *Galinsoga parviflora*, (B), *Conyza bonariensis* (C), FeCl₃ & NPs

Functional Group (FTIR) Analysis

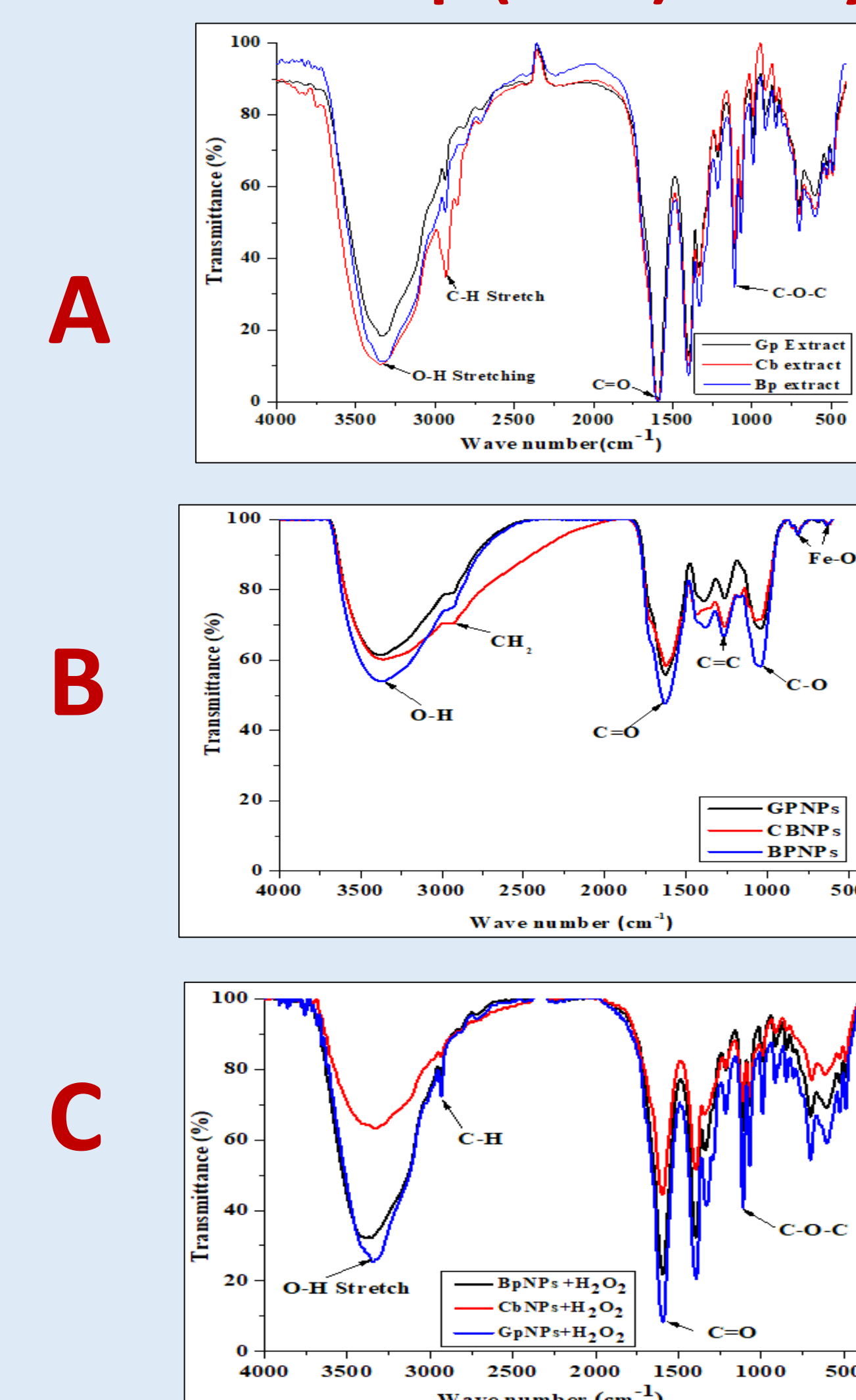


Figure 5: (A) *B. pilosa*, *C. bonariensis*, & *G. parviflora* extracts, (B) *B. pilosa*, *C. bonariensis*, & *G. parviflora* NPs, (C) *B. pilosa*, *C. bonariensis*, & *G. parviflora* Nanoparticle (NPs) after degradation of methylene blue

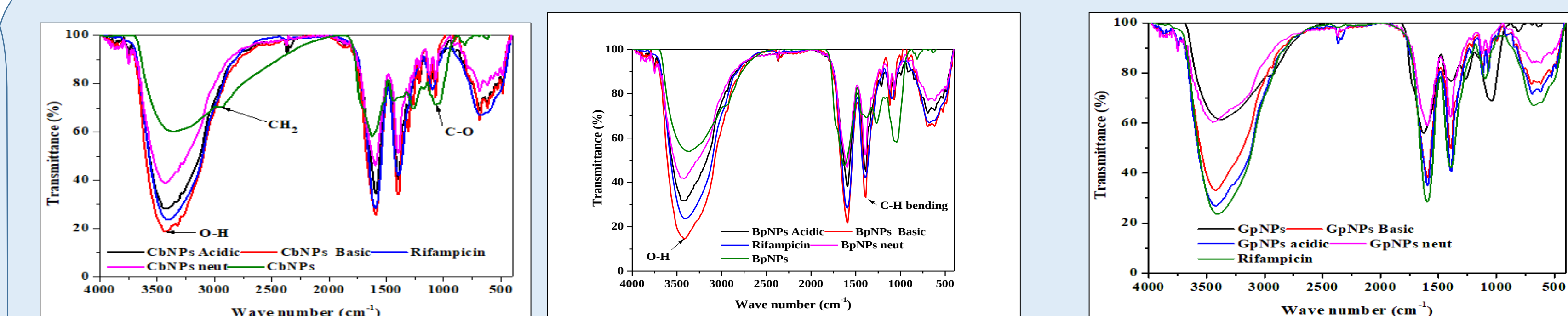


Figure 6: (A) *C. bonariensis* NPs after degradation of Rifampicin different pH, (B) *B. pilosa* NPs after degradation of Rifampicin different pH, & (C) *G. parviflora* NPs after degradation of Rifampicin at different pH

Functional group analysis was performed using FTIR. The extracts, NPs and NPs after degradation showed a shift in the functional groups revealing the nature of particles before and after degradation.

Morphology (SEM)

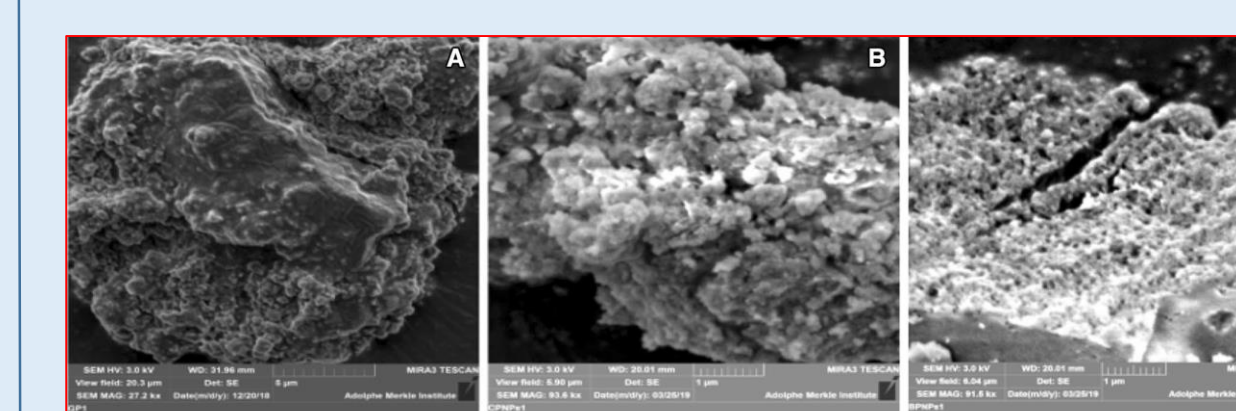


Figure 7: Morphology of NPs

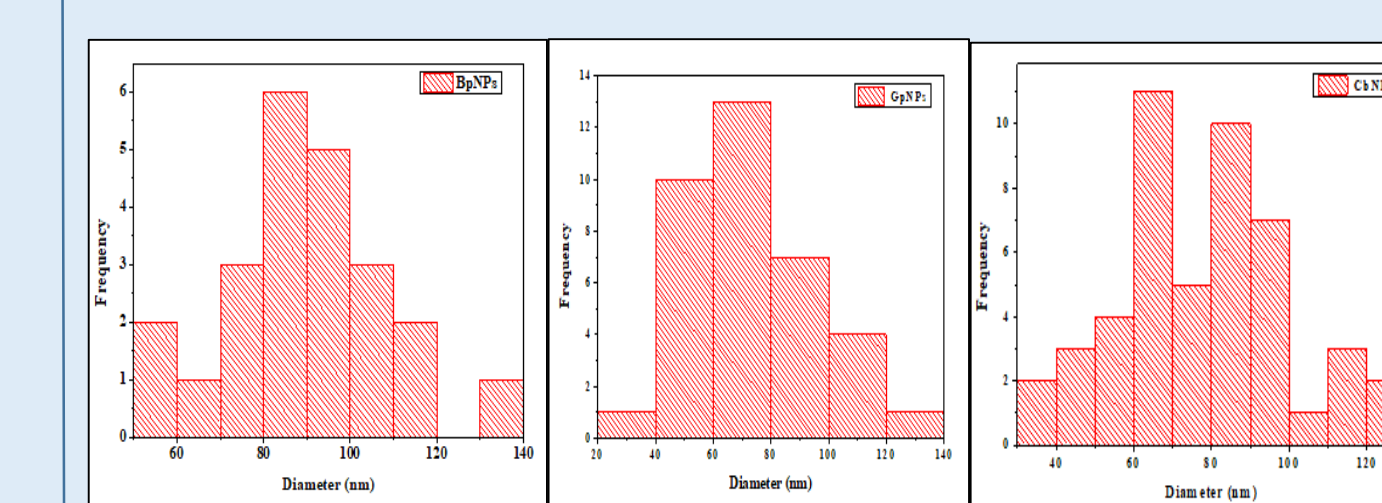


Figure 8: Size distribution

Degradation Studies

$$\ln A_t = -kt + \ln A_0 \quad \frac{1}{A_t} = -kt + \frac{1}{A_0} \quad \ln K_{eq} = \frac{\Delta H}{RT} + \frac{\Delta S}{R}$$

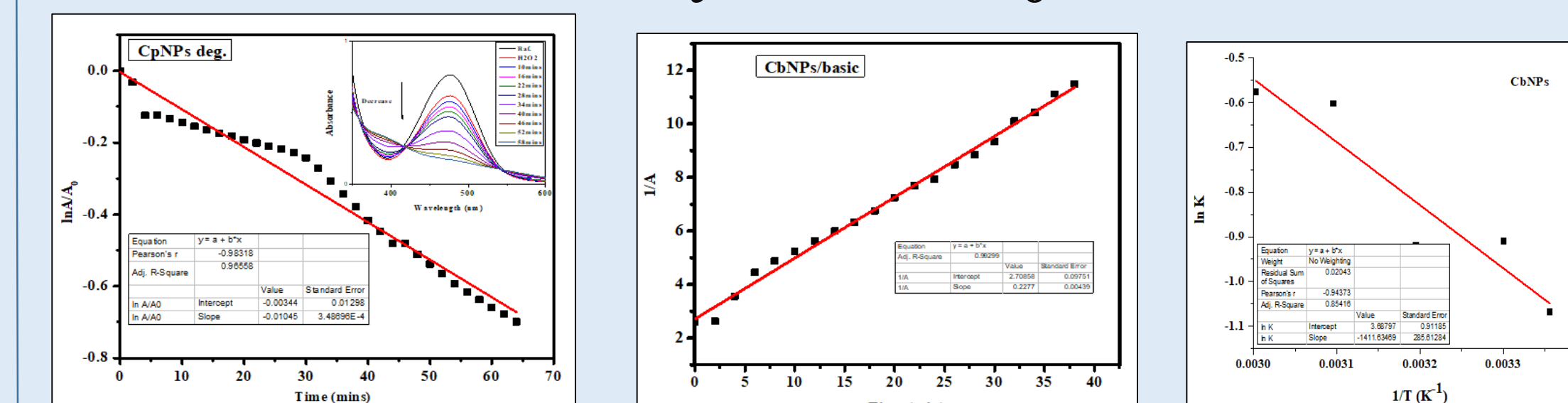


Figure 10: First, Second order and the Vant Hoff's Plot

References

- [1] <https://doi.org/10.1038/s41598-022-10092-4>
- [2] <https://doi.org/10.1016/j.enceco.2021.11.002>
- [3] <https://doi.org/10.1016/j.envpol.2019.01.108>

XRD (Crystallinity)

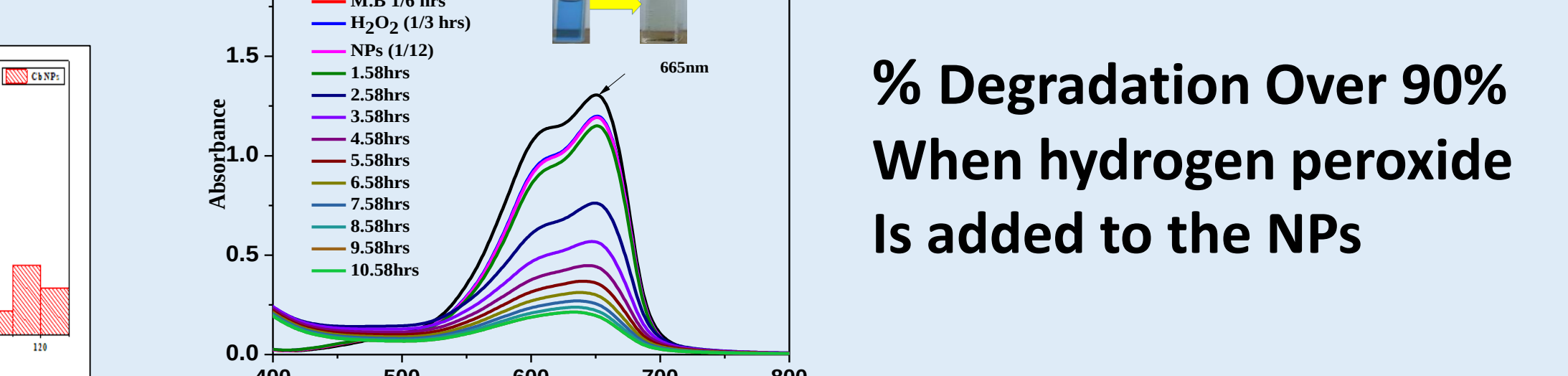
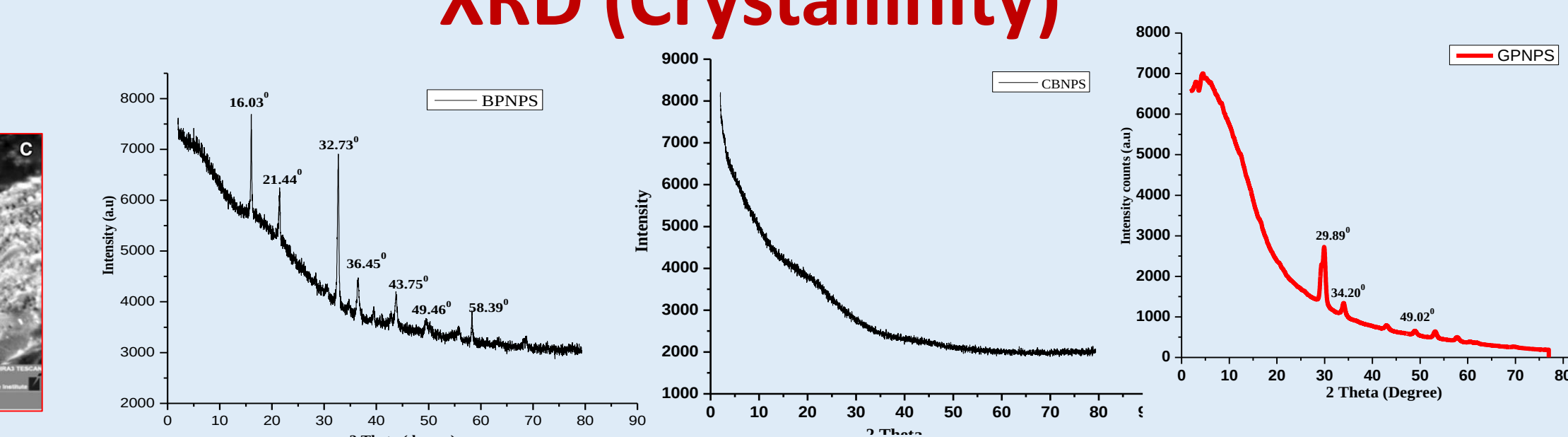


Figure 9: XRD peaks and the Degradation of Methylene blue

% Degradation Over 90%
When hydrogen peroxide
Is added to the NPs

Conclusion

Natural products reduce metal ions to NPs which have catalytic effect & Remove organic pollutants in water by over 85%. Entropy change high.