

Fish Gelatin Nanoparticles: An Effective Carrier for Curcumin

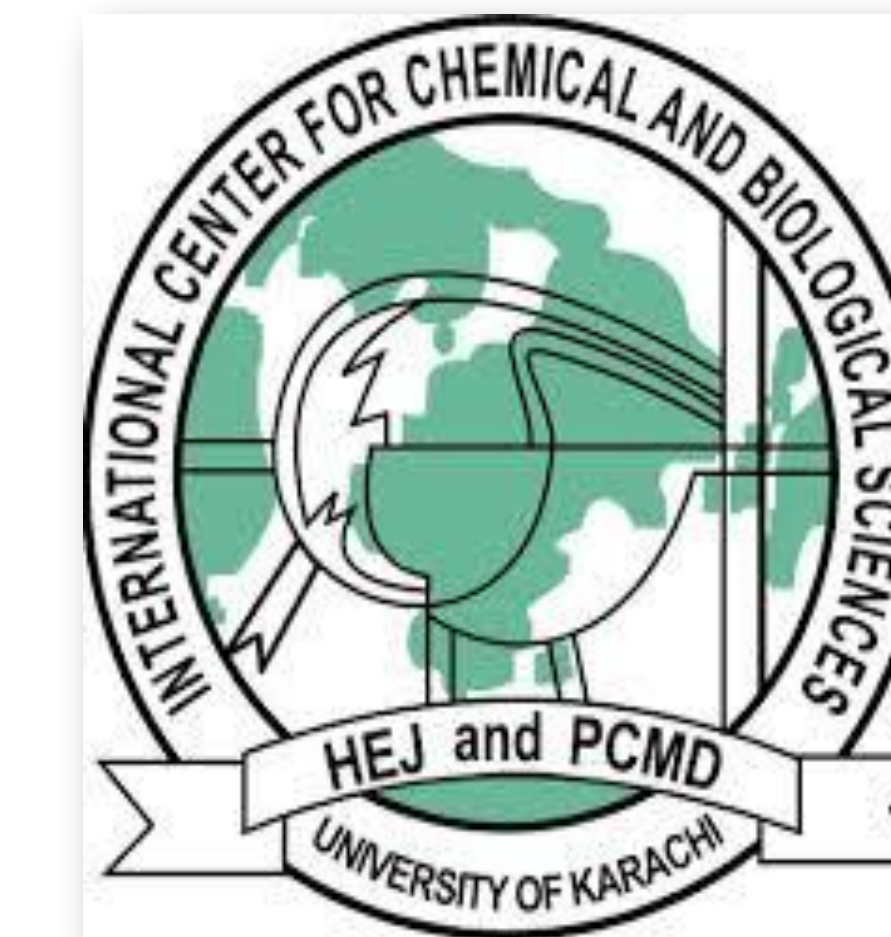
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Good Health & Well-Being
This study advances accessible, plant-safe cancer therapeutics doubling curcumin's anticancer potency through sustainable nanocarrier design

Introduction

- **Curcumin** has strong antioxidant, anti-inflammatory, antimicrobial, and anticancer potential, but its clinical use is limited by poor solubility, instability, and low bioavailability.
- **Gelatin** is an attractive carrier because it is biocompatible, biodegradable, non-toxic and FDA-GRAS, but mammalian gelatin has religious, safety, and sourcing limitations.
- **Fish gelatin** offers a safer, more acceptable alternative and is still underexplored for nanoparticle-based drug delivery.
- **The study aimed** to fabricate glutaraldehyde-crosslinked fish gelatin nanoparticles (FGNPs) as a carrier for curcumin and evaluate their loading, release, stability, and biological activity.

Methods

Fabrication

Chemical crosslinking (glutaraldehyde) of fish gelatin (30 mg/mL, pH 9) — solvent-free, one-step

Loading

Curcumin encapsulated pre-crosslinking; efficiency quantified by UV-Vis (425 nm)

Characterization

DLS, AFM, SEM, TGA, FTIR, fluorescence spectroscopy & microscopy, molecular docking

Release kinetics

In vitro, PBS pH 7.4, 48 h; modeled by zero-order, first-order, Higuchi, Hixson-Crowell & Korsmeyer-Peppas

Biological activity

MTT cytotoxicity (BJ fibroblasts); anticancer (MCF-7, HeLa); antioxidant by DPPH & FRAP

Results

FGNPs Optimization

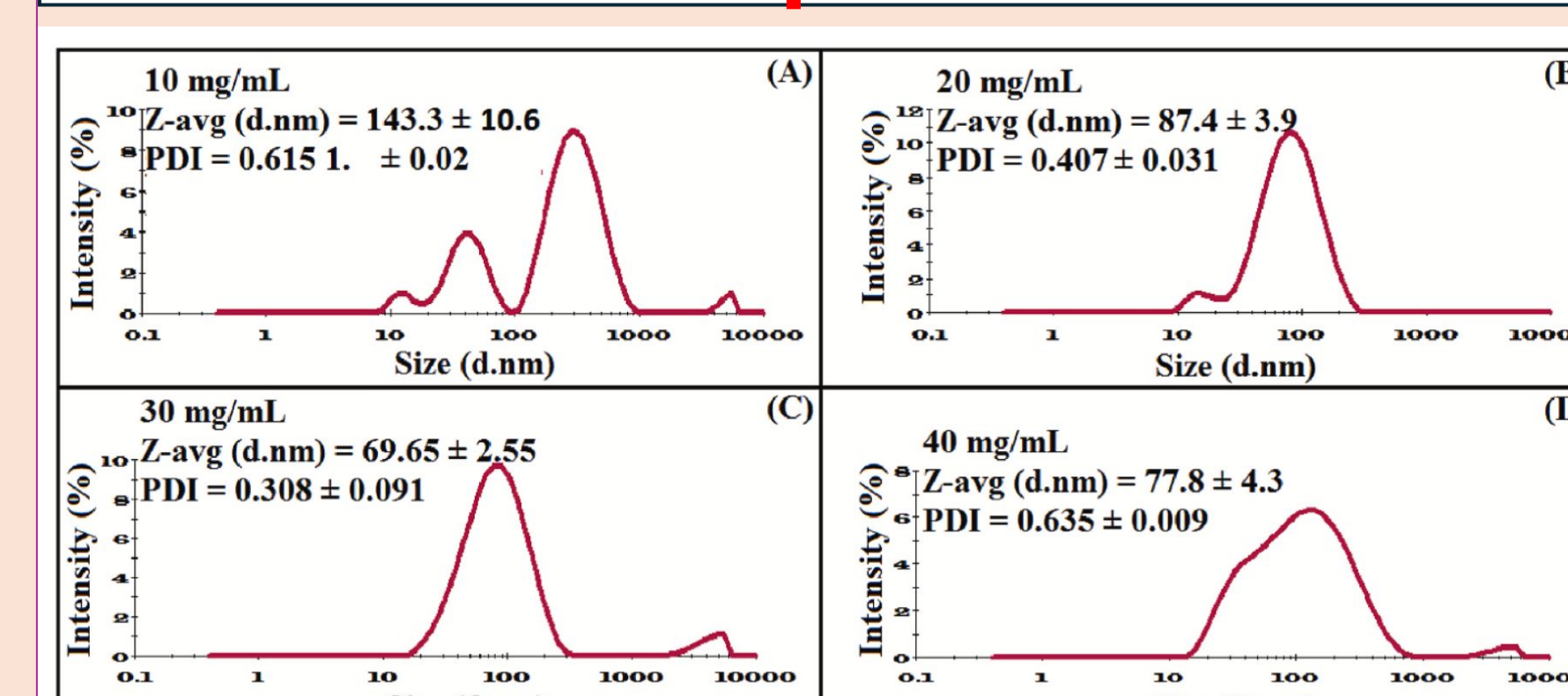


Fig. 1. DLS size of FGNPs vs gelatin concentration. Optimal: 30 mg/mL gelatin, 69.65 nm, PDI 0.308.

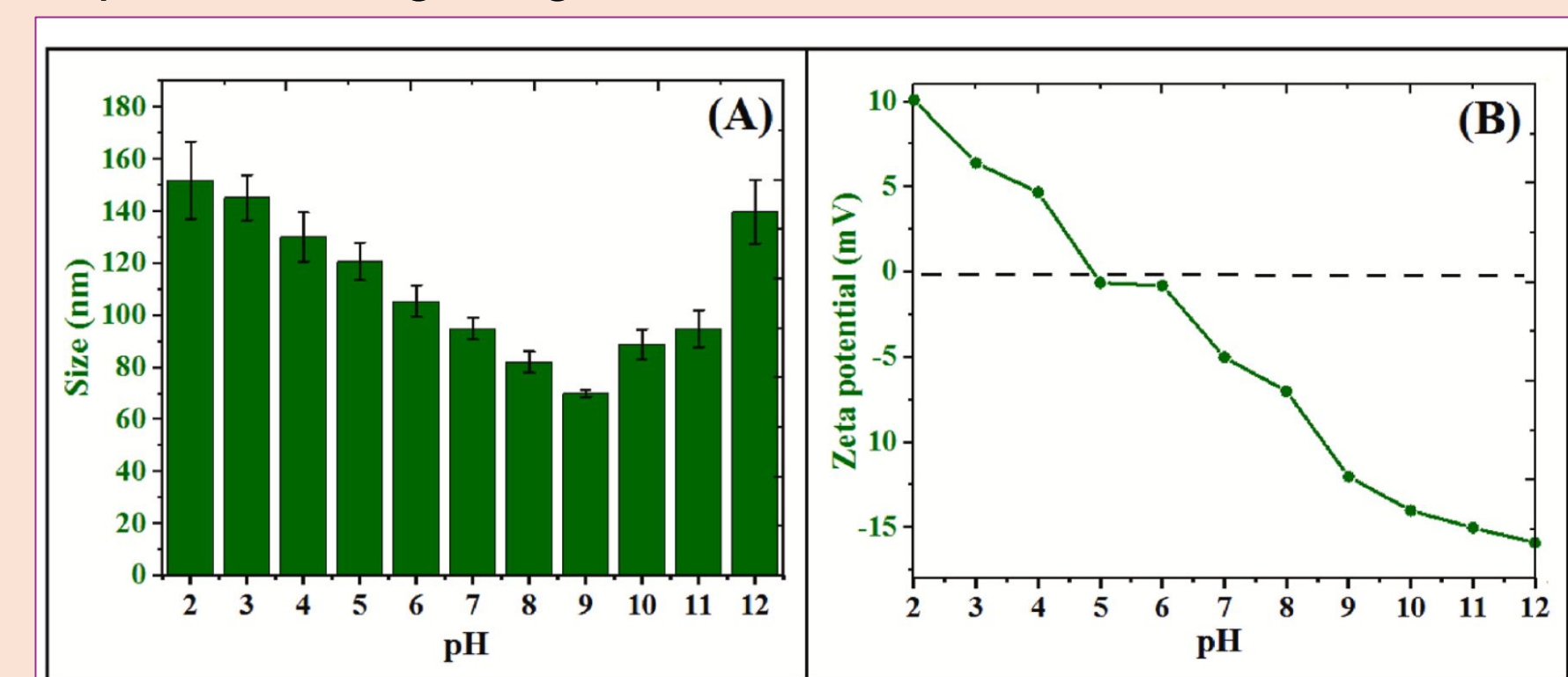


Fig. 2. Effect of pH on FGNP DLS size and zeta potential. Optimal: pH 9, 69.65 nm, PDI 0.308, -12.6 mV.

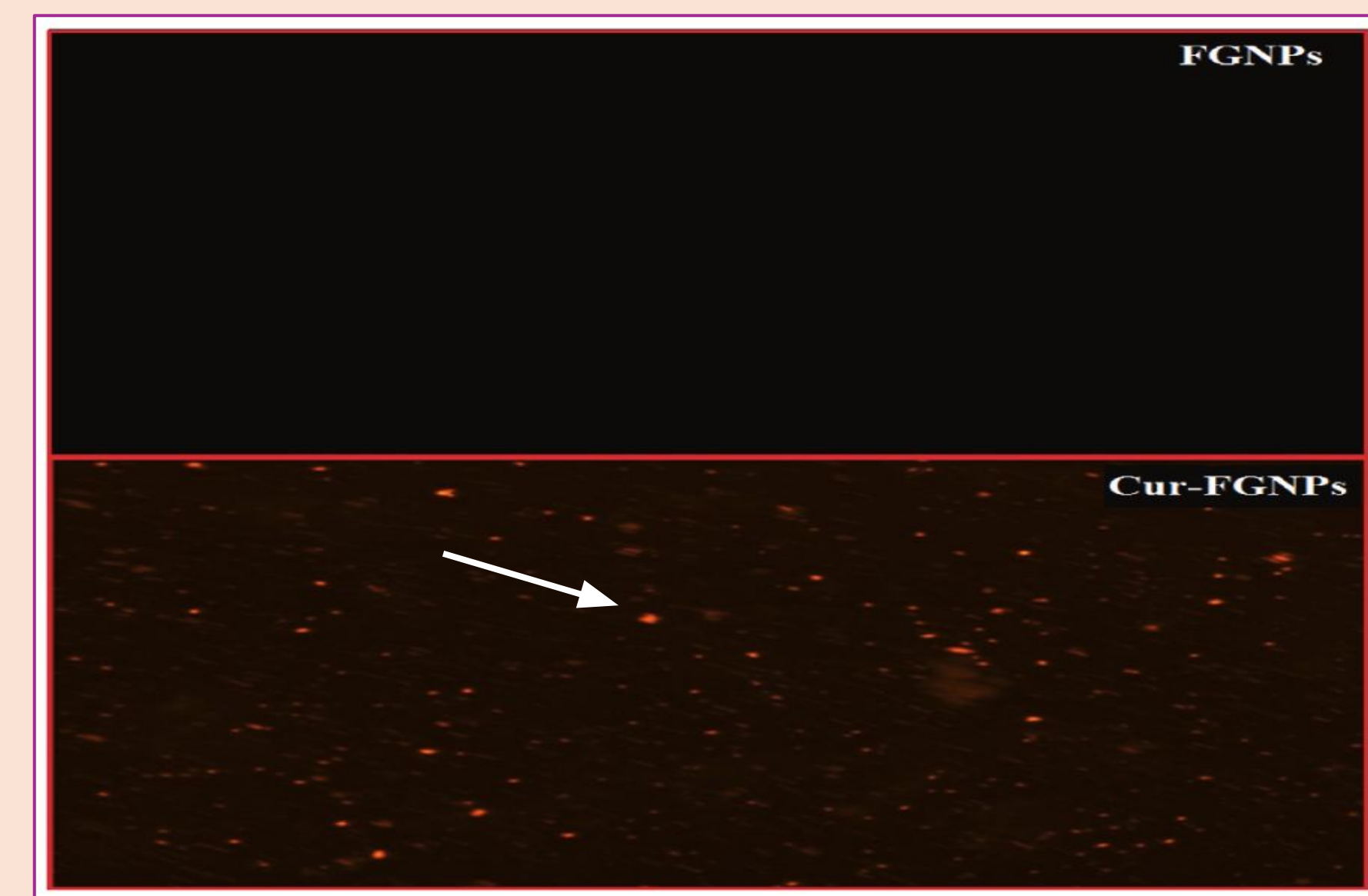


Fig. 3. Fluorescence microscopy FGNPs vs CUR-FGNPs. Cur-FGNPs show strong red autofluorescence (ex. 544 nm / em. 570 nm); FGNPs alone show none.

Characterization of FGNPs

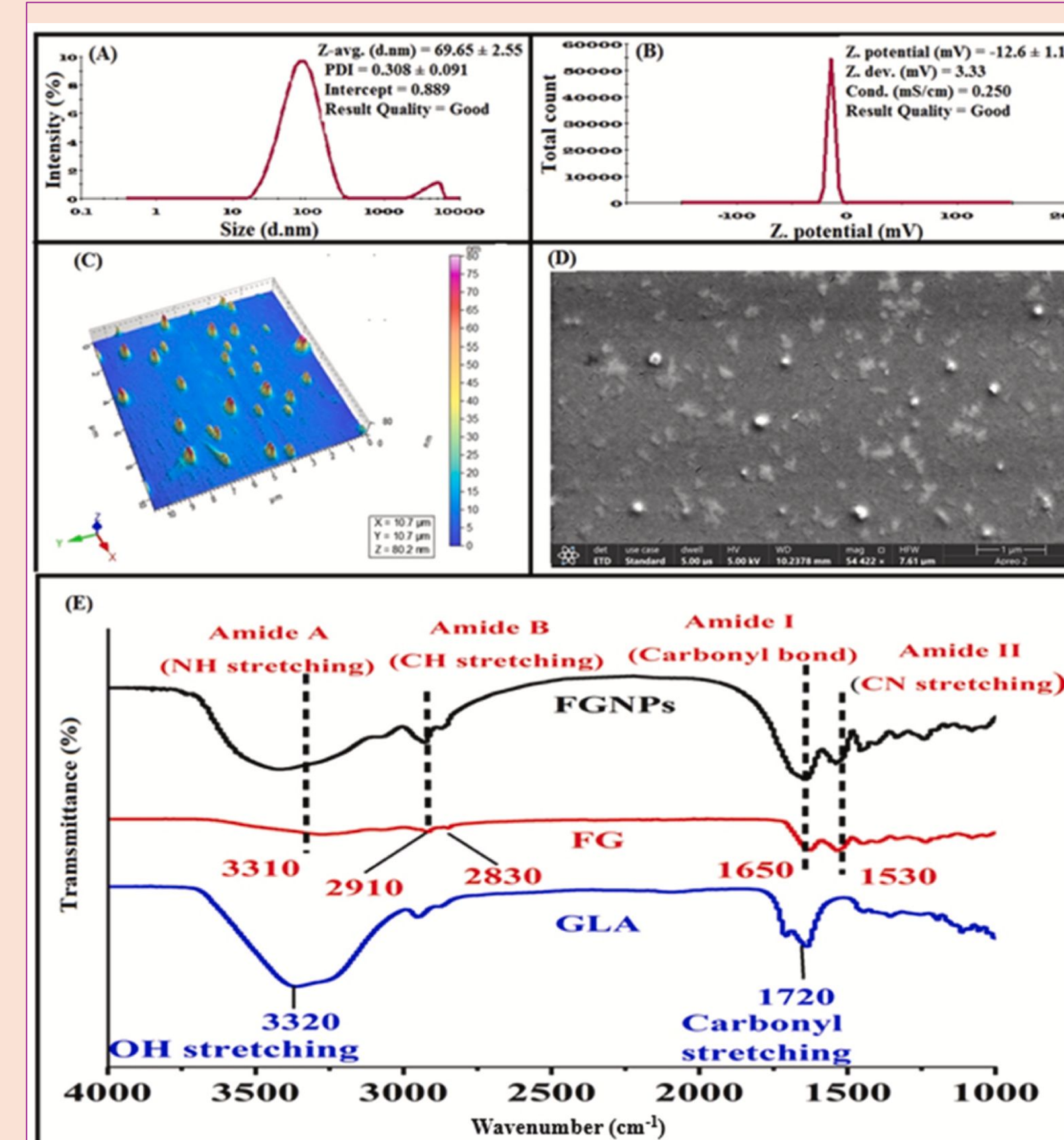


Fig. 4. DLS, ZETA, AFM, SEM & FT-IR FG-NPs (A-E) Size 69 nm, Zeta -12.6 mV, AFM & SEM; spherical uniform particles, FTIR successful glutaraldehyde crosslinking via Schiff base formation.

Molecular Docking

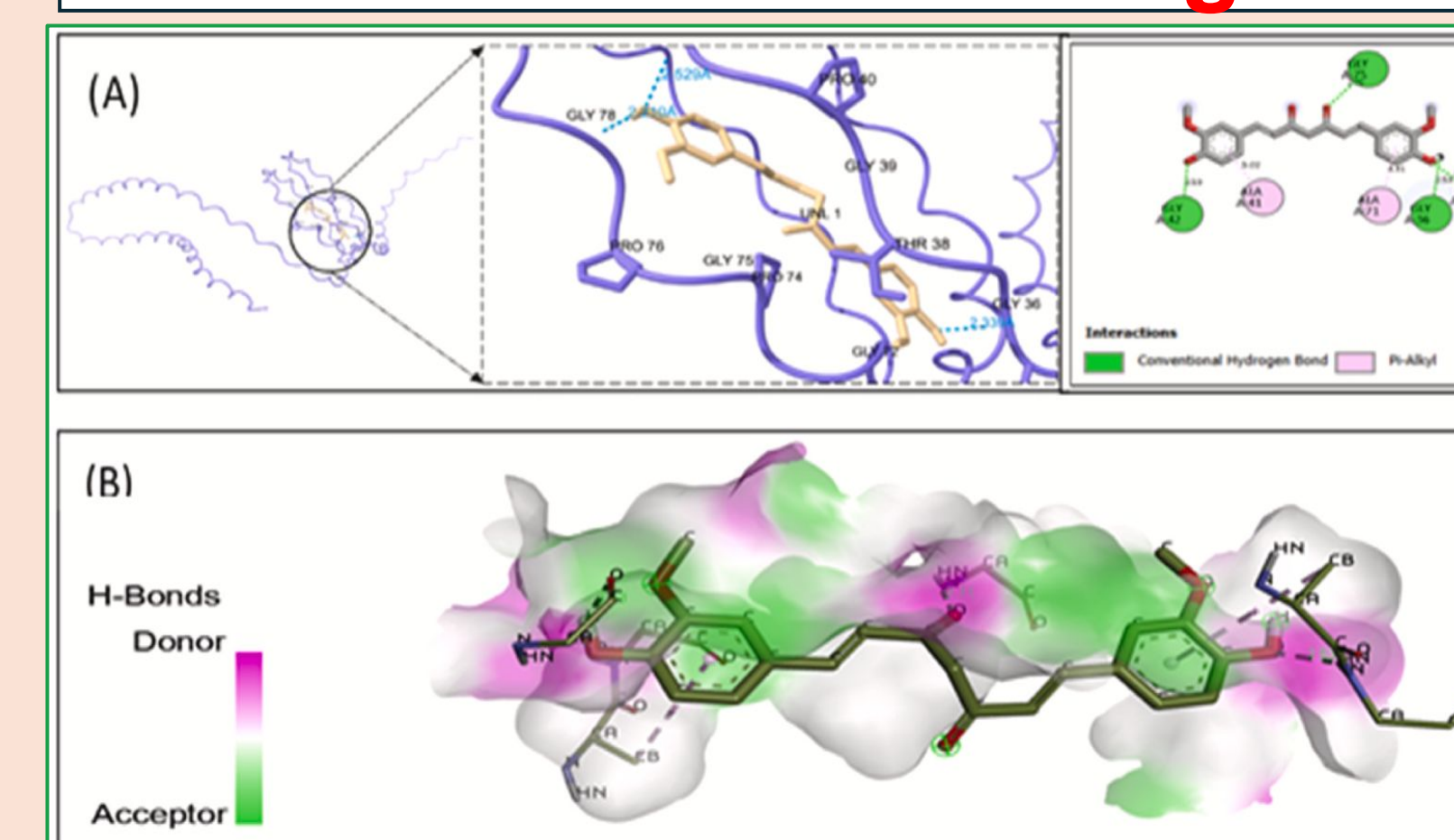


Fig. 5. Molecular Docking shows CUR binds with FGNPs via H-bonding and pi/alkyl hydrophobic interactions with (Binding energy: -4.85 kcal/mol).

Fig. 8. Antioxidant Activity of Cur-FGNPs significantly improved versus free CUR owing to enhanced solubility and stability in FGNPs.

Characterization of CUR-FGNPs

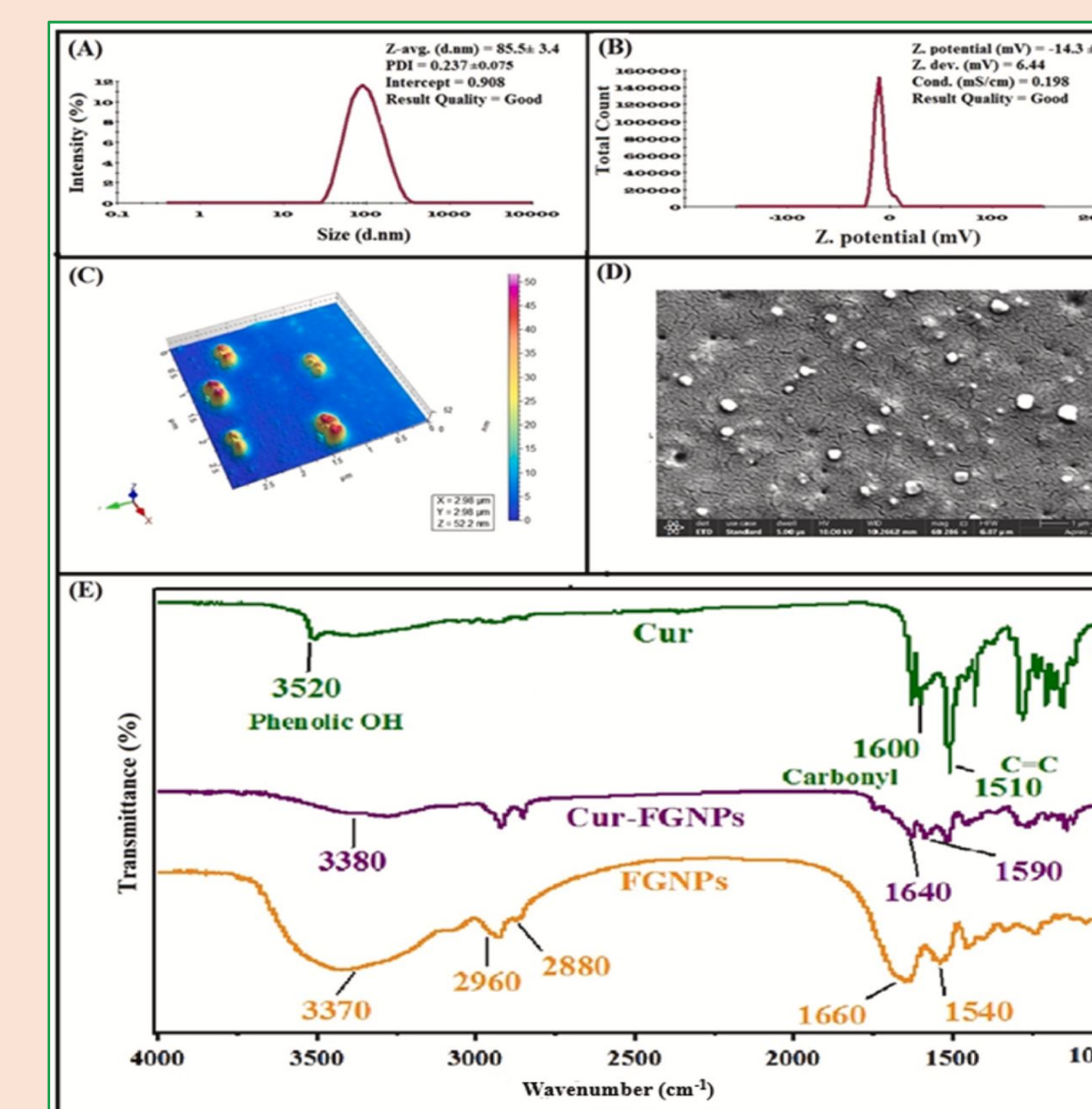


Fig. 6. DLS, Zeta, AFM, SEM & FT-IR Cur-FGNPs (A-E). DLS size increased to ~85.5 nm, zeta increased to -14.3 mV, FT-IR shifts validate the encapsulation and interaction between curcumin and the FGNPs matrix.

Biological Activity

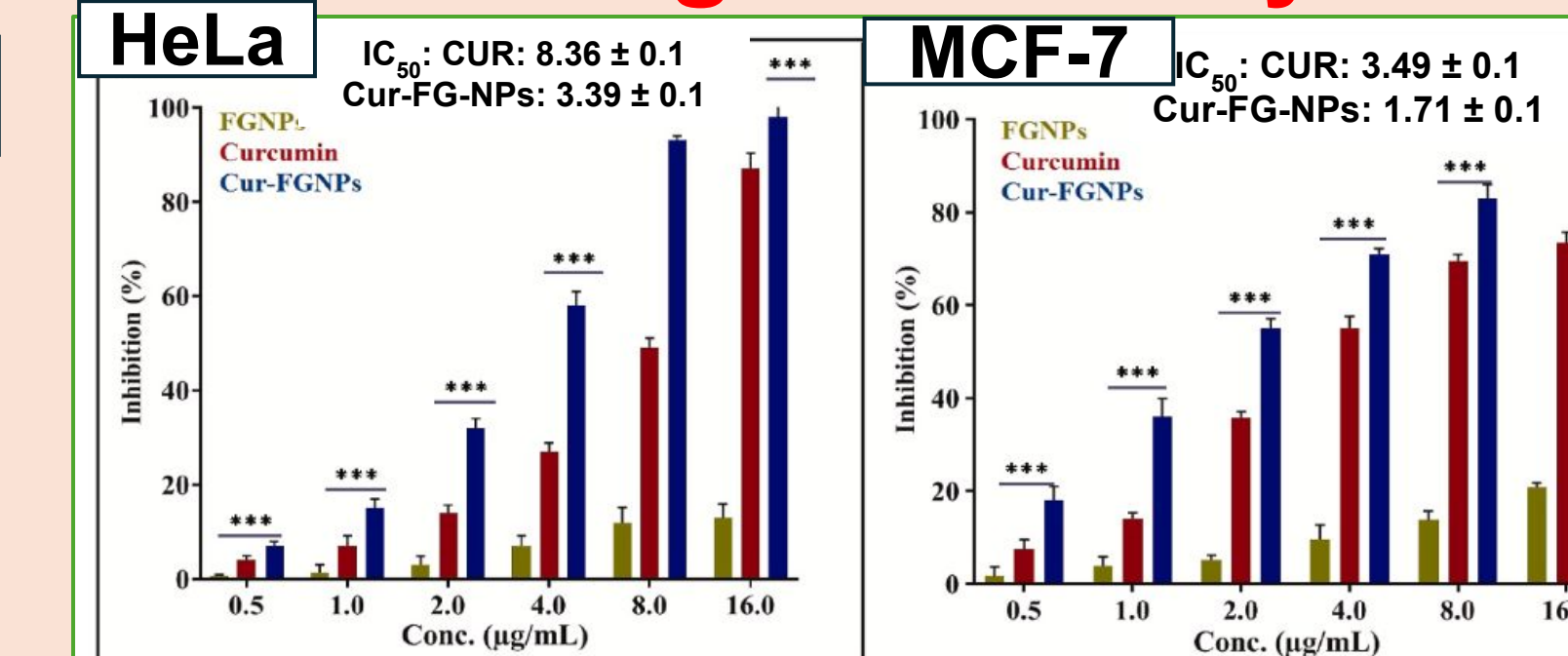
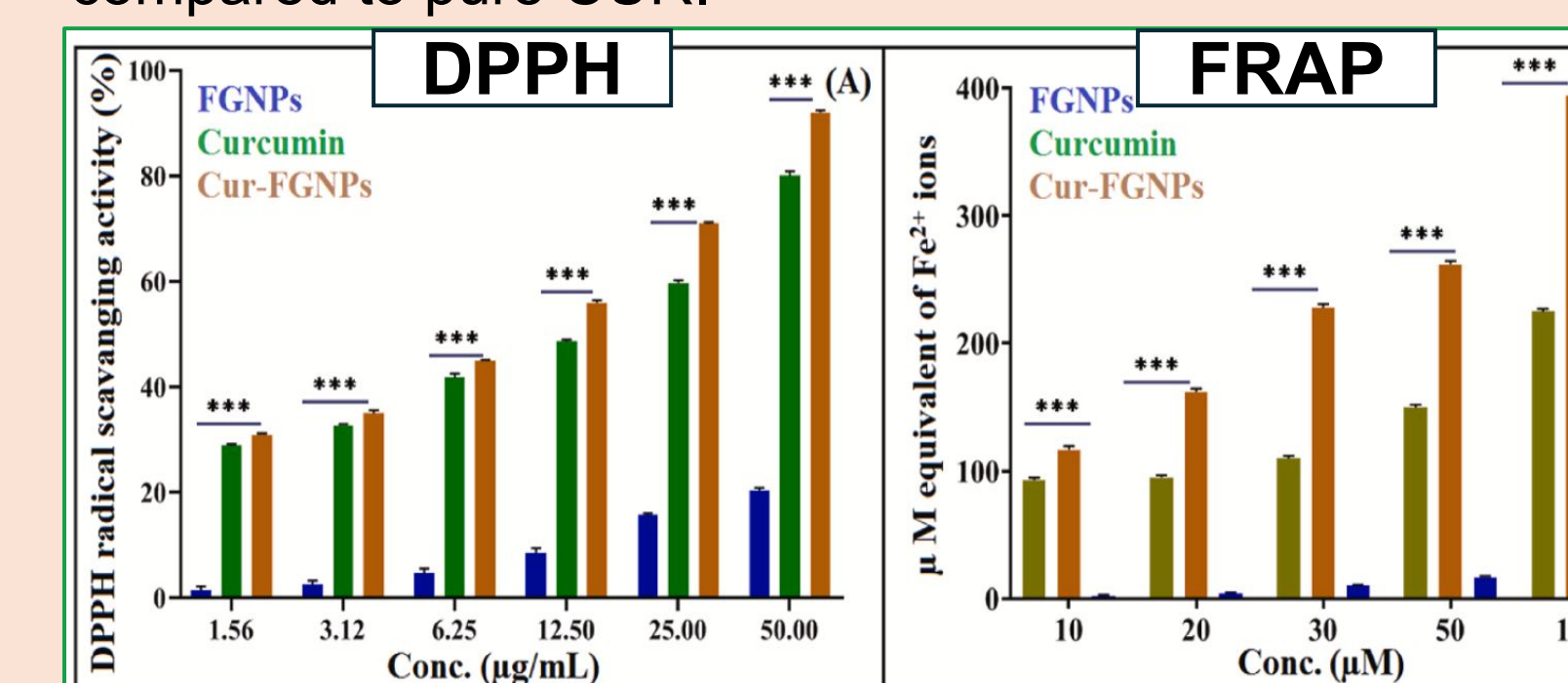


Fig. 7. Anticancer Activity of Cur-FGNPs effectively doubled against HeLa and MCF-7 cancer cell lines compared to pure CUR.



Conclusions

- FGNPs (~70 nm, PDI 0.308) were successfully fabricated via a simple, solvent-free chemical crosslinking method.
- Curcumin loading reached about **75%**, and the formulation showed sustained release of >80% for more than 48 hours.
- Cur-FGNPs were biocompatible with normal BJ fibroblasts.
- Anticancer potency of curcumin doubled in MCF-7 and HeLa cell lines when delivered via Cur-FGNPs.
- Cur-FGNPs also improved antioxidant activity compared with curcumin.
- Overall, fish gelatin nanoparticles appear to be a promising carrier for hydrophobic nutraceuticals, especially curcumin. It has potential for further in vivo development.

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Full Paper

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