TOWARDS TRANSFORMATIVE HEALTHCARE APPLICATIONS: BIOMIMETIC HYDROXYAPATITE SYSTEMS FOR CONTROLLED DRUG DELIVERY

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ABSTRACT

This research is devoted to the development of a biomimetic system based on hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$, HA), modified with silver nanoparticles and infrared-sensitive polyelectrolytes to prolong drug release.

Keywords: silver nanoparticles, hydroxyapatite, photothermal stimulation

INTRODUCTION

The use of infrared radiation stands out as a very promising method among the current drug release techniques

- IR cannot activate pure HA.
- Surface functionalization or trigger needed.
- We have chosen to incorporate Ag NPs inside the HA rings in order to address this.

METHODS

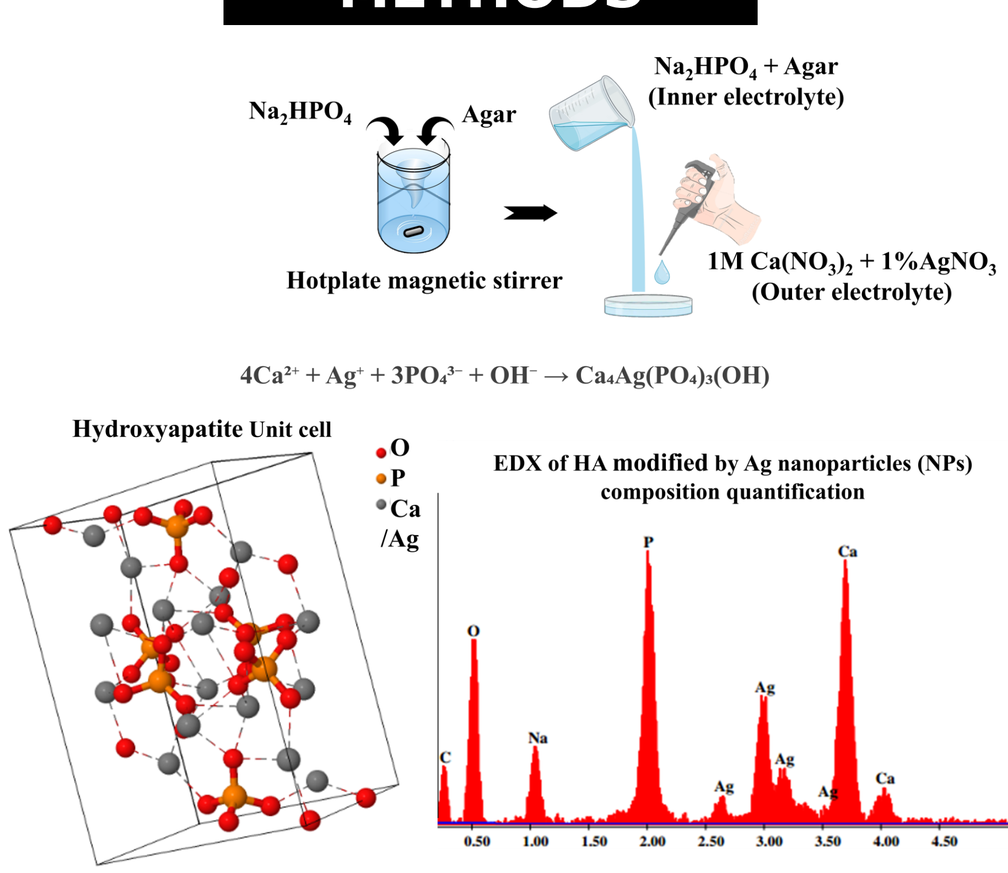

Figure 1. Research plan. Limited Diffusion Aggregation where outer electrolyte, 1M $CaCl_2$ (control), 1M $Ca(NO)_3$, or a combination of weight percent $AgNO_3$ and $Ca(NO)_3$ was diffused into an inner electrolyte solution that contained agar and 0.2M Na_2HPO_4.

RESULTS

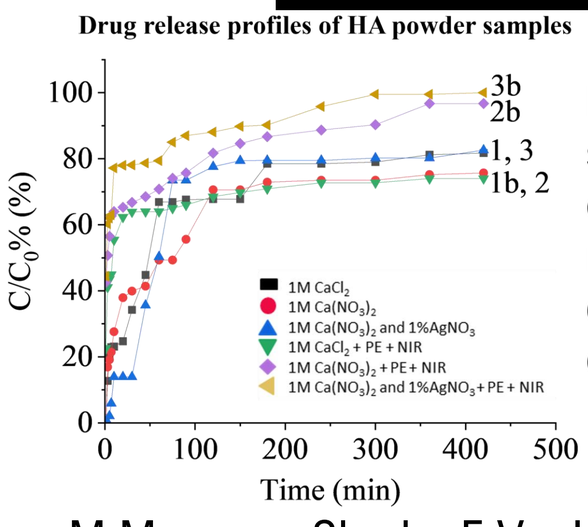

Figure 2. The HA sample powders obtained from the HA rings formed with different outer electrolytes at 12 h

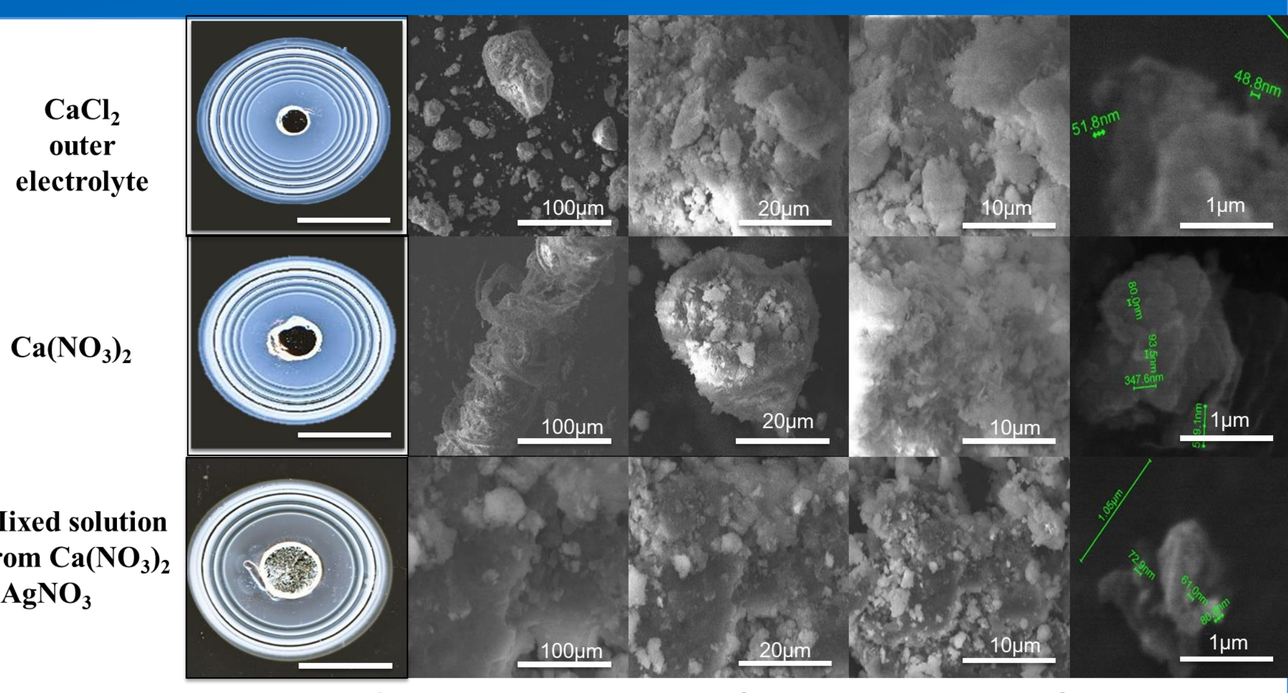

Figure 3. The HA sample powders obtained from the HA rings formed with different outer electrolytes at 12 h ((HA obtained using $CaCl_2$: plot 1), HA (obtained using $Ca(NO_3)_2$: plot 2), and HA modified by Ag nanoparticles (NPs): plot 3

HA rings formed via ion diffusion in agar.

- **$CaCl_2$/$Ca(NO_3)_2$:** Regular spacing (p-factor ≈ 1.0).
- **$Ca(NO_3)_2$+$AgNO_3$:** Irregular spacing (p-factor = 0.81).

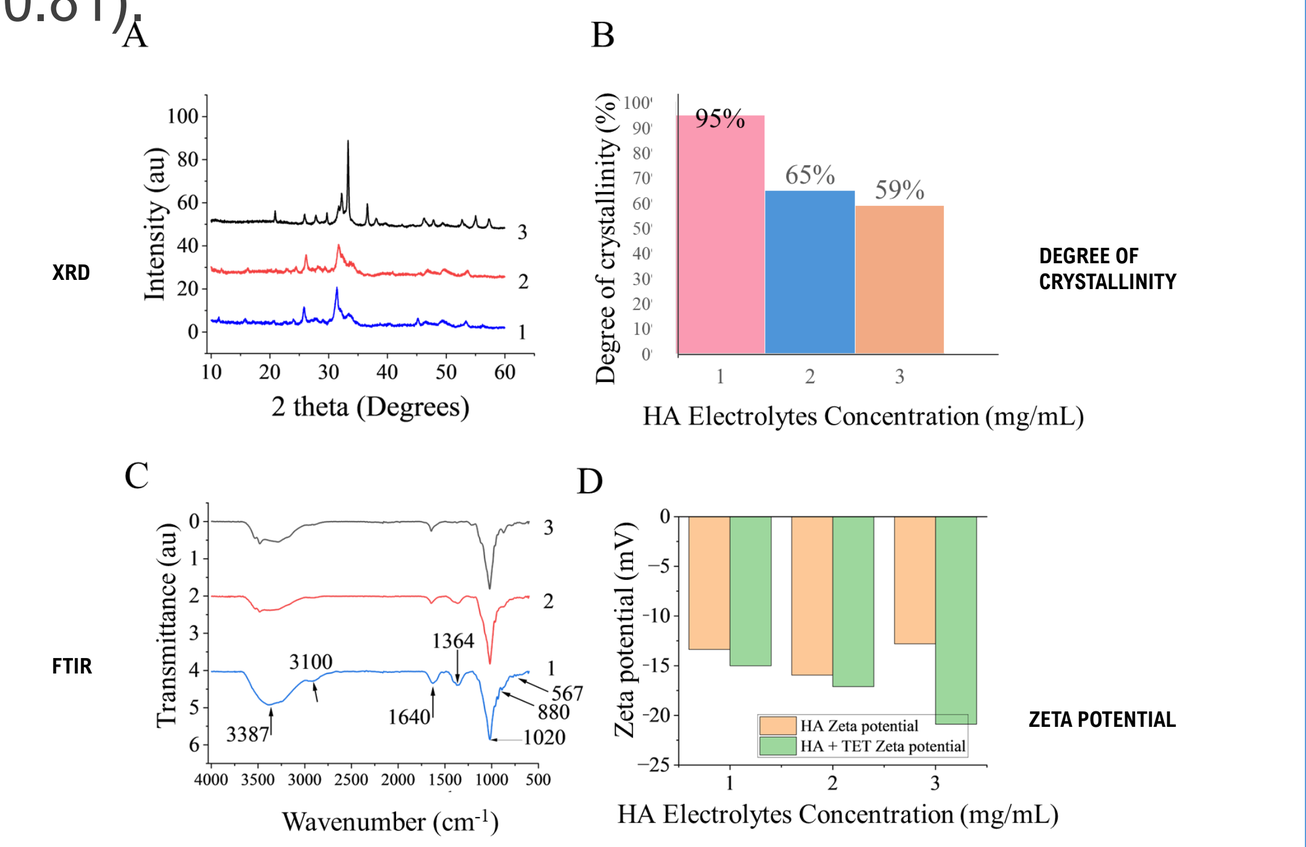

Figure 4. XRD spectra confirm the crystalline structure of HA-Ag, with no impurity peaks (A) and FTIR spectra (C) Degree of crystallinity from XRD data for HA samples prepared with different outer electrolytes (B) and zeta potential (D) of HA samples prepared with different outer electrolytes before and after loading with tetracycline. (plots 1-3).

CONCLUSION

We successfully engineered IR-responsive HA-Ag composites for controlled antibiotic delivery. Offering 52% more tetracycline release than control, enabled spatiotemporal control of drug release, achieving a 4-fold increase in release rate upon NIR irradiation compared to the passive diffusion control, promising for bone implant coatings.

REFERENCES

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