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Magnesium Oxide (MgO) encapsulated liposomes for cosmetic applications

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INTRODUCTION & AIM

Magnesium oxide nanoparticles (MgO NPs) possess excellent antimicrobial, biocompatible, and non-toxic properties, making them promising for low-cost and stable cosmetic applications. Their bactericidal activity, particularly against E. coli and S. aureus, increases with smaller particle size due to greater surface interaction. The antimicrobial mechanism involves membrane disruption and Reactive Oxygen Species (ROS) generation. Compared to other metal oxides, MgO is safer and more metabolizable, supporting long-term use. This study aimed to encapsulate MgO NPs in liposomes to enhance their safety, stability, and efficacy for cosmetic applications.

METHOD

Synthesis of MgO NPs

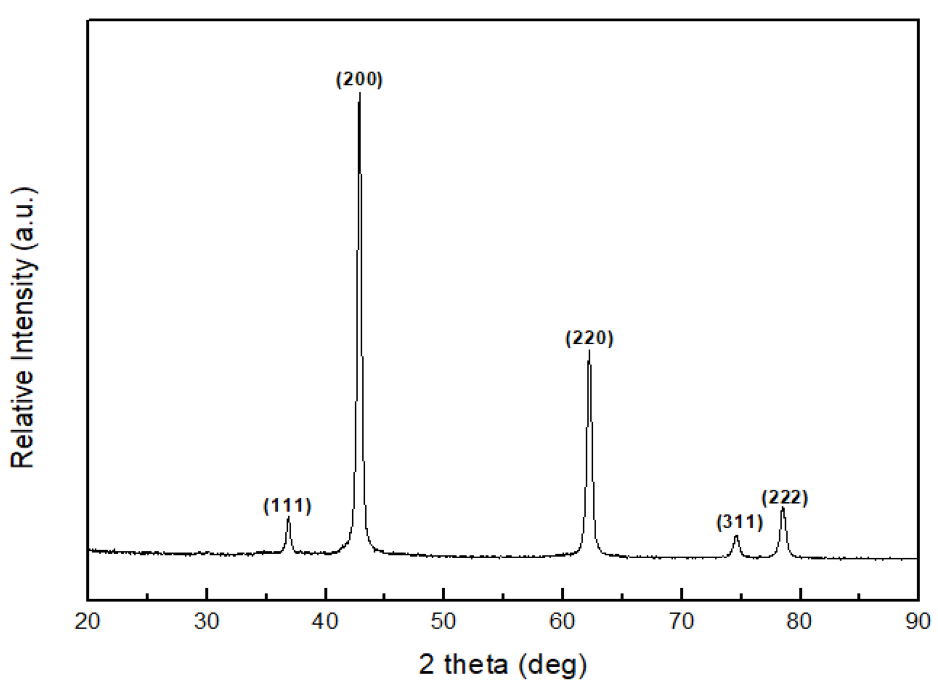
MgO nanoparticles were synthesized through a facile co-precipitation method via the following chemical reaction:

$$NaOH_{(aq)} + Mg(NO_3)_{2(aq)} \rightarrow Mg(OH)_{2(s)} + 2NaNO_{3(aq)}$$

The $Mg(OH)_2$ precipitate was then converted into MgO nanoparticles during drying and calcination processes.

Characterization of MgO NPs

The XRD pattern confirmed the cubic structure of the sample, with an estimated crystallinity of 70.4%. The observed peaks correspond to the characteristic planes of pure MgO, while the average crystal size was found equal to **20.7 nm** using the Debye-Scherrer equation. The sharp peaks indicate high crystallinity, while no further impurities were detected.



Liposome Preparation and Encapsulation

Liposomes were prepared using the thin-film hydration method with DSPC and DOPC lipids. The as-synthesized MgO nanoparticles were incorporated into the liposomes during the hydration step. Subsequently, Poloxamer 407 was added to enhance the stability of the lipid carriers.

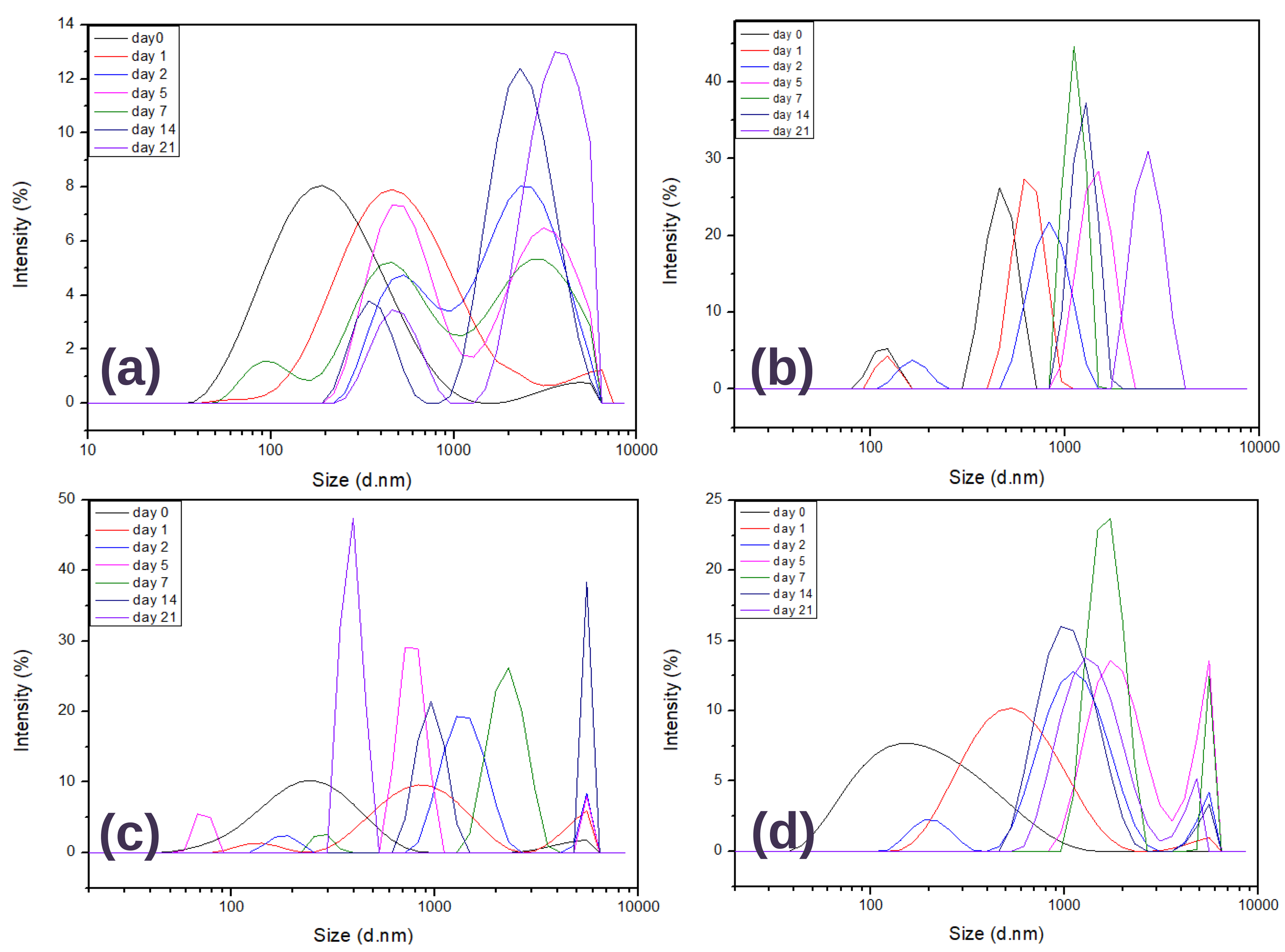
RESULTS & DISCUSSION

DLS Stability Analysis

The hydrodynamic diameter, polydispersity index (PDI) and zeta potential of the liposomal formulations were observed for a period of 21 days using the dynamic light scattering (DLS) method.

- **a) DSPC-DOPC**: The particle size gradually increases over time, indicating some instability and aggregation.
- **b) DSPC-DOPC+MgO**: The size is more dispersed due to MgO-lipid interactions, but the system gains additional functionality (antibacterial-antioxidant).
- **c) DSPC-DOPC-Poloxamer**: The particle size remains stable, as Poloxamer prevents aggregation and maintains uniformity.
- **d) DSPC-DOPC-Poloxamer+MgO**: This system is the most balanced, showing stable and uniform size while providing functional benefits, making it ideal for cosmetic applications.

The liposomal formulations maintain a negative zeta potential and decreased PDI over 21 days, indicating good colloidal stability, while Poloxamer enhances uniformity and MgO provides functional benefits without compromising stability.



FUTURE WORK / REFERENCES

- Explore **probe sonication** for enhanced nanoparticle uniformity.
- Optimize **synthesis parameters, lipid composition, and loading capacity** to improve system stability.
- Perform **comparative evaluation** with ZnO, Ag, and TiO_2 nanoparticles regarding efficacy and safety.
- Assess **biocompatibility and formulation potential** in topical delivery applications.

CONCLUSION

Poloxamer 407 prevents aggregation by significantly enhancing the stability and uniformity of DSPC-DOPC liposomes and maintaining particle size and zeta potential over time. MgO nanoparticles provide additional functional benefits, including antioxidant and antimicrobial properties, without affecting colloidal stability. The combination of Poloxamer and MgO results in a robust, functional liposomal system ideal for cosmetic applications.

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