RELIANCE

Optimal silica pore size for essential oil encapsulation

Silica pores of 3-4 nm enabling efficient encapsulation and release of carvacrol, guiding optimal design of mesoporous silica delivery systems

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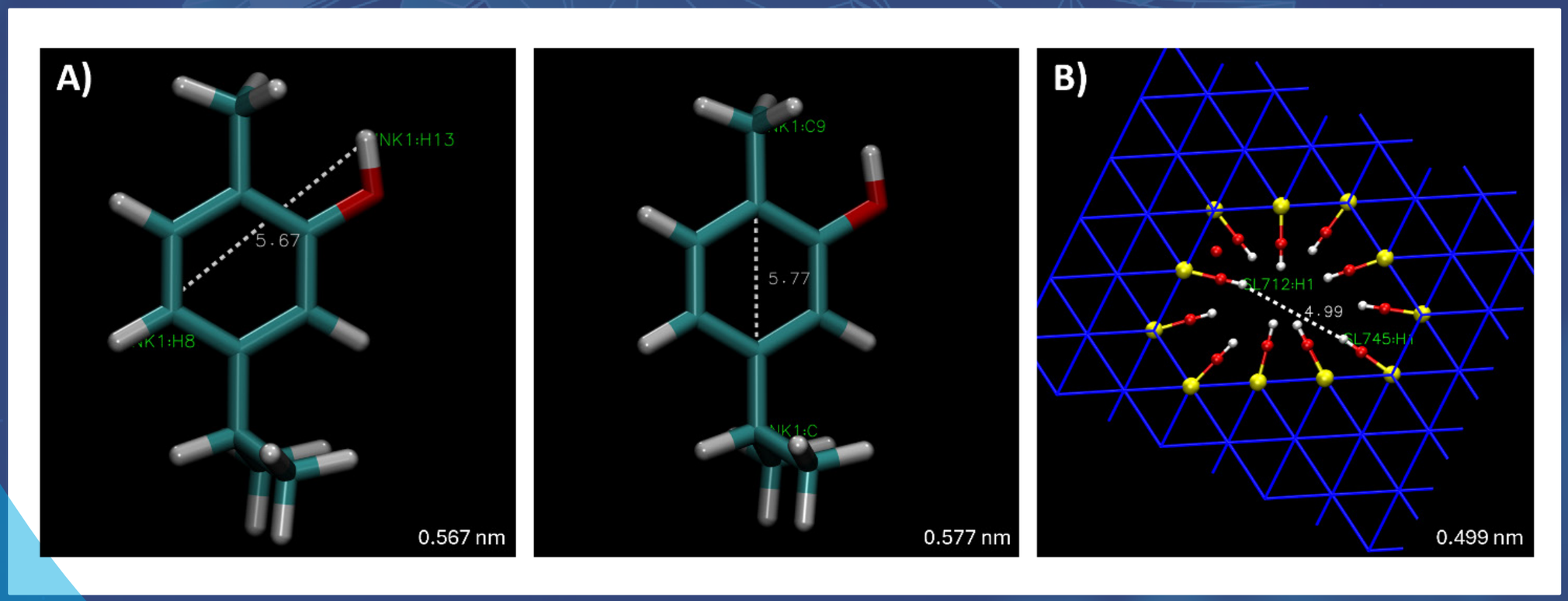
The Challenge

To obtain first proof for the transferability, repeatability and scalability of the manufacturing process of antimicrobial mesoporous silica nanoparticles

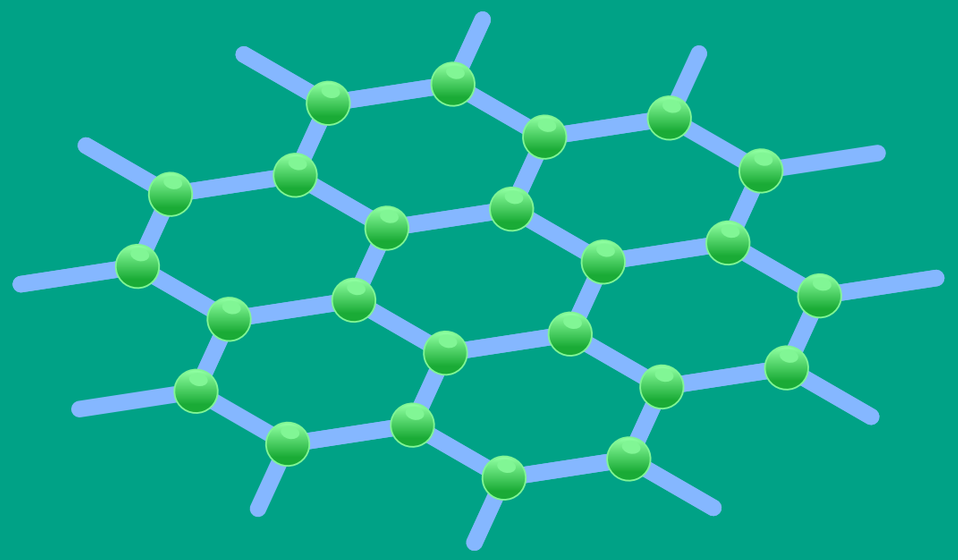


The Achievements

- Evaluated carvacrol behavior in silica pores of 1-4 nm diameter though molecular simulations

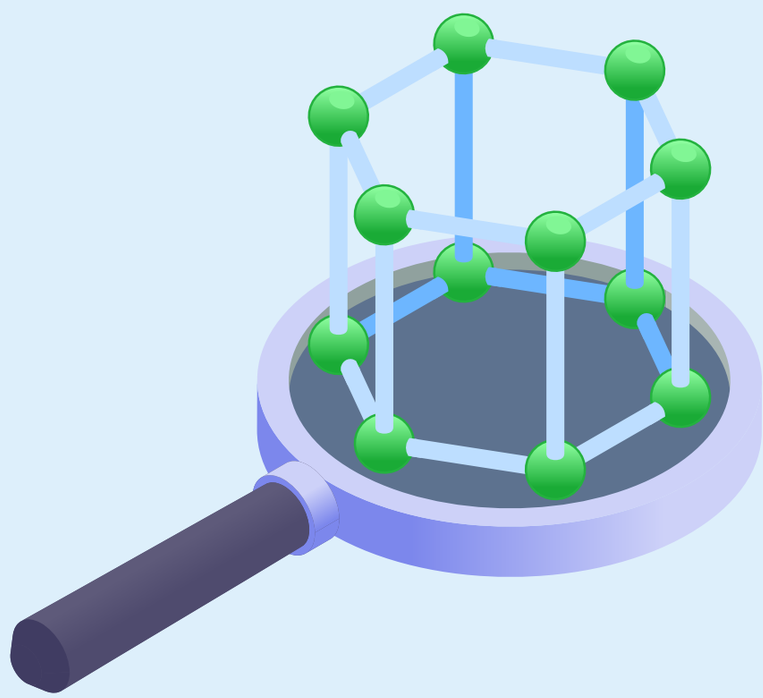
- Very small pores cannot accommodate molecules and prevent their release

- Silica pores ≥ 3 nm allow encapsulation, mobility and release



Key Conclusions

- 1 nm pores are too small to accommodate carvacrol
- 2 nm pores confine molecules, limiting their release
- 3-4 nm pores enable efficient loading and molecular mobility



Recommendations

For material design:

- **Tune pore size to control release rate**
- **Avoid pores smaller than 2 nm for essential oil delivery systems**

Who is this result for?

- Nanomaterial developers
- Antimicrobial coating manufacturers
- Food packaging industries
- Researchers working on nano-delivery systems

Long-term Impact

- **Optimizing pore size improves the delivery of natural antimicrobial compounds and supports the development of smart antimicrobial delivery systems**

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