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DESIGN AND CHARACTERISATION OF ZnAl-LDH-PALMITIC ACID NANOCOMPOSITES WITH PH-RESPONSIVE RELEASE AND ANTIMICROBIAL ACTIVITY

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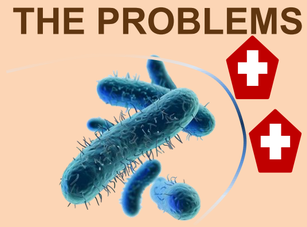
INTRODUCTION & AIM

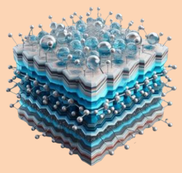
THE PROBLEMS



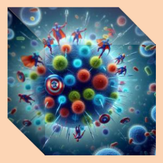
Antimicrobial resistance (AMR) makes infections harder to treat

Rapid drug release reduce effectiveness and leads to AMR

THE IDEA



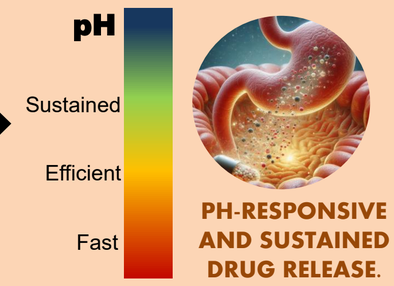
Layered Double Hydroxide (LDH) nanocomposite allows controlled, pH responsive drug release



Palmitic Acid (PA) Is a good antibacterial agent but poor solubility.

THE SOLUTION

Loading PA into LDHs can improve its delivery and extend its antibacterial effect.

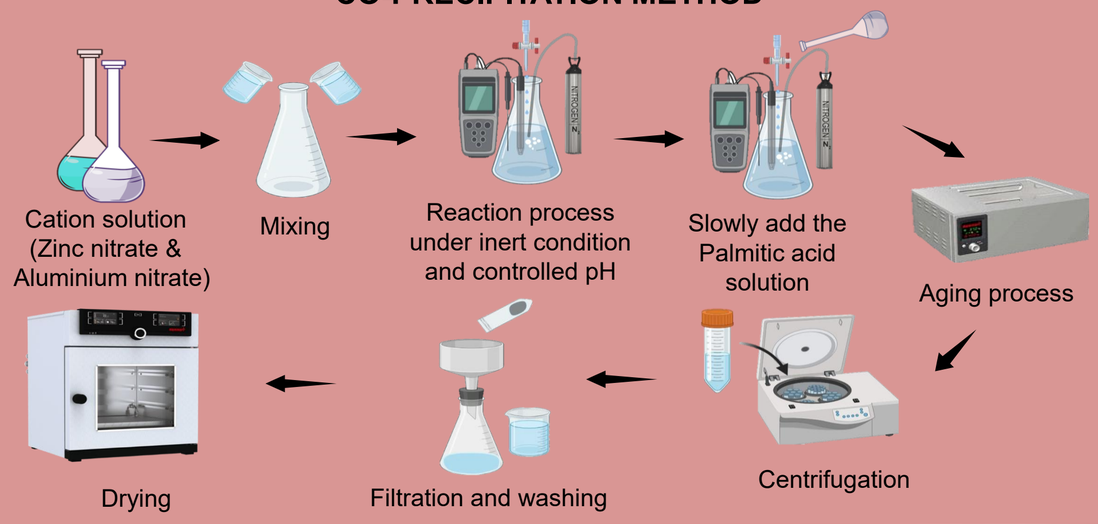


PH-RESPONSIVE AND SUSTAINED DRUG RELEASE.

AIM To develop ZnAl–LDH–PA nanocomposite that protects the drug and improves bioavailability.

METHODOLOGY

SYNTHESISING ZnAl-LDH-PA NANOCOMPOSITE VIA CO-PRECIPITATION METHOD



CHARACTERISATION

- **PXRD** : crystalline structure study.
- **FTIR-ATR** : Structural and chemical composition study
- **FESEM-EDX** : morphological and elemental study
- **TGA-DTG** : Thermal stability and decomposition study
- **BET** : Surface area and porosity of study

CONTROLLED RELEASE STUDY AT DIFFERENT pH MEDIA

LHD-PA was placed in 3.5 mL of prepared PBS solution in a cuvette.

- pH 1.2 (gastric fluid)
- pH 4.8 (lysosomal)
- pH 7.4 (plasma)

Run at predetermined λmax = 222 nm

ANTIBACTERIAL STUDY

Disk Diffusion Method against *E. Coli* and *S. Aureus*

The bacteria were spread on MHA

Sample discs were placed on agar and incubated.

After incubation, the inhibition zone was measured.

CONCLUSION & FUTURE WORKS

KEYFINDINGS

- ZnAl–LDH–PA nanocomposite was successfully synthesised.
- Demonstrates controlled and pH-responsive drug release behavior.
- Most efficient release: 68% at pH 4. Most sustained release: at pH 7.4
- Shows promising antibacterial activity.

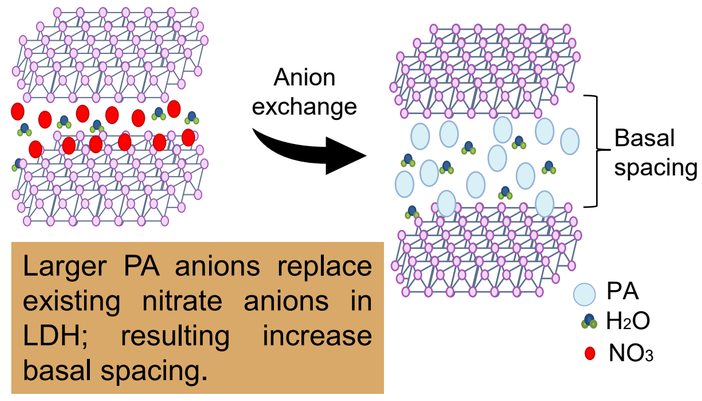
FUTURE WORKS

- Expand its antibacterial scope by testing against diverse bacterial strains.
- Validate its biocompatibility, toxicity, and release efficiency.
- Explore potential for localized antibacterial delivery in medical applications.

REFERENCE

[1] Jadam, M. L., Syed Mohamad, S. A., Zaki, H. M., Jubri, Z., & Sarijo, S. H. (2021). Antibacterial activity and physicochemical characterization of calcium-aluminium-ciprofloxacin-layered double hydroxide. Journal of Drug Delivery Science and Technology, 62.

RESULTS & DISCUSSION



Larger PA anions replace existing nitrate anions in LDH; resulting increase basal spacing.

Successful intercalation of PA into LDH layer

- ✓ Increase in basal spacing (PXRD)
- ✓ Removal of nitrate group (FTIR)
- ✓ Addition of palmitate group (FTIR)
- ✓ Increase surface area (BET)
- ✓ Removal of nitrogen element (EXD)
- ✓ Increase thermal stability (TGA)

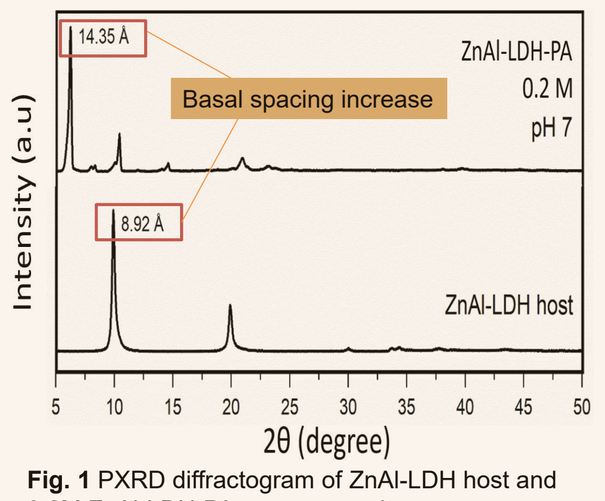


Fig. 1 PXRD diffractogram of ZnAl-LDH host and 0.2M ZnAl-LDH-PA nanocomposite.

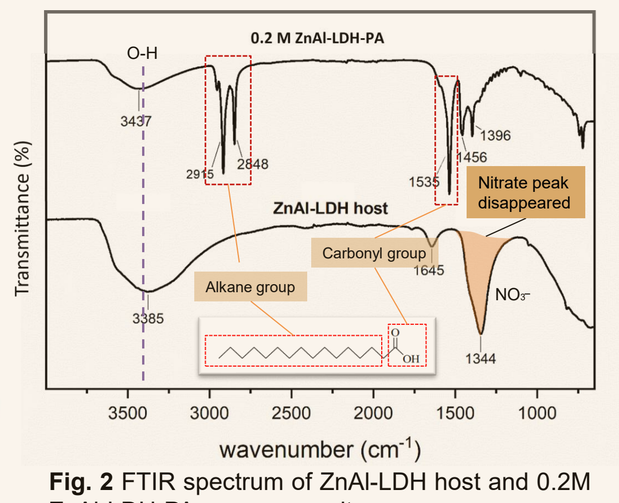


Fig. 2 FTIR spectrum of ZnAl-LDH host and 0.2M ZnAl-LDH-PA nanocomposite.

Table 1 Surface area and pore volume

Sample	Surface area (m^2g^{-1})	pore volume (cm^3g^{-1})
ZnAl-LDH host	4.82	4.0
ZnAl-LDH-PA	21.35 increase	50.0 increase

H3-type: Indicative of slit-shaped pores (IUPAC)

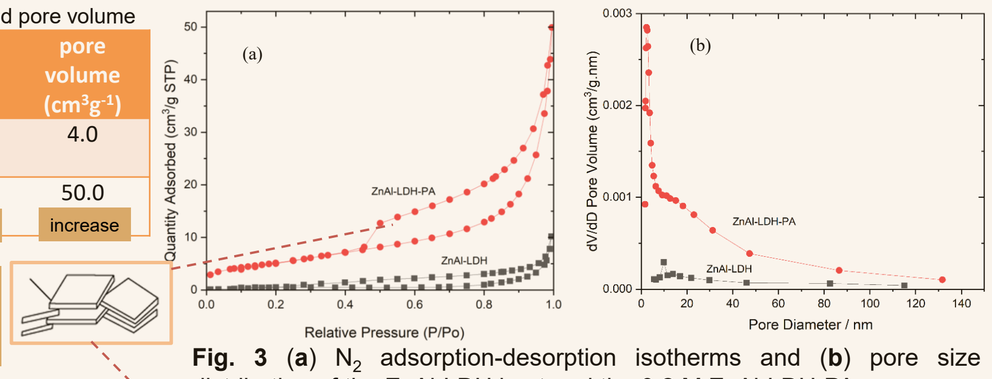


Fig. 3 (**a**) N_2 adsorption-desorption isotherms and (**b**) pore size distribution of the ZnAl-LDH host and the 0.2 M ZnAl-LDH-PA.

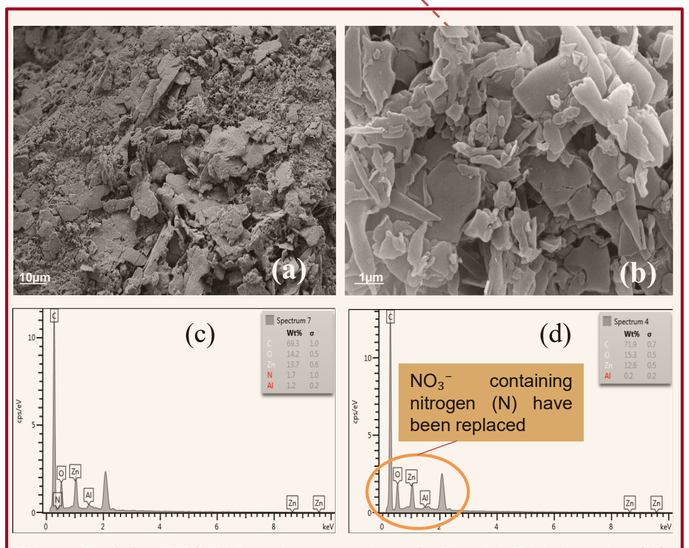


Fig. 4 (**a**) FESEM micrograph of ZnAl-LDH host; (**b**) FESEM micrograph of 0.2M ZnAl-LDH–PA; (**c**) EDX spectrum of ZnAl-LDH host; (**d**) EDX spectrum of 0.2M ZnAl-LDH–PA.

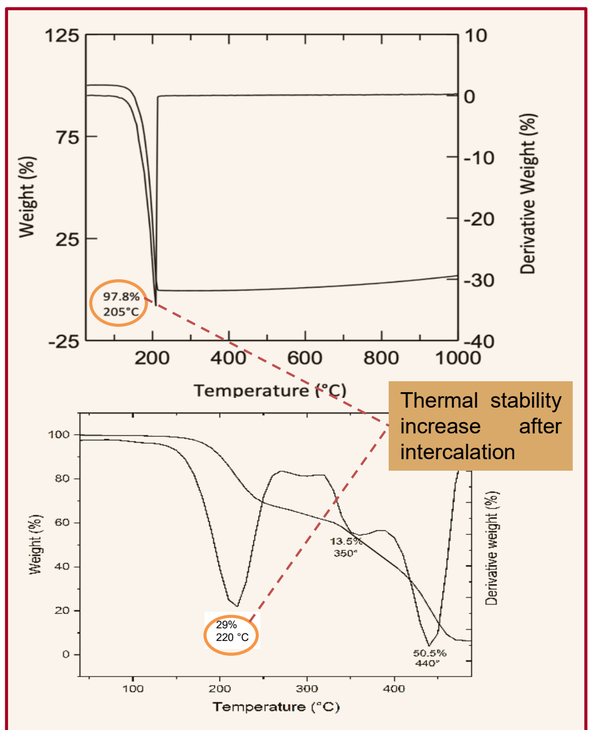


Fig. 5 Thermogram of (a) Palmitic acid and (b) 0.2 M ZnAl-LDH-PA.

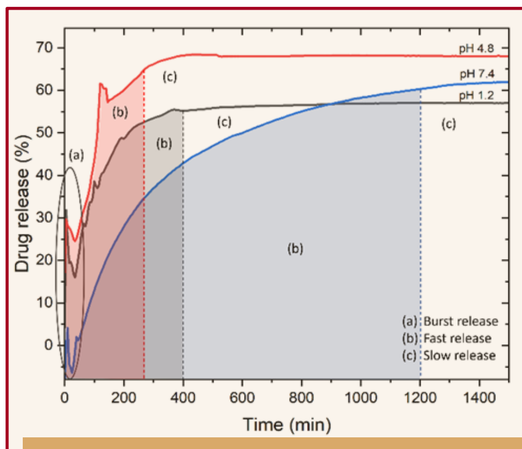


Fig. 6 The release profile of PA from ZnAl-LDH-PA in different pH levels of PBS solution

- **Maximum** release observed:
  - **68% at pH 4.8 (540 min)**
  - **57% at pH 1.2 (1060min)**
  - **62% at pH 7.4 (1500 min)**
- The most **sustained** drug release occurs at **pH 7.4** where the drug is released gradually over a prolonged period.

Table 2 Inhibition zone diameter of PA, ZnAl-LDH host, and ZnAl-LDH-PA on *S. aureus* & *E. coli*

	Inhibition zone (cm)	
Bacteria	S. Aureus	E. Coli
ZnAl-LDH Host	0.6	0.6
Drug (PA)	0.6	0.6
ZnAl-LDH-PA	0.6	0.7
Positive Control	3.0	3.0
Negative Control	-	-

The intercalation of PA into ZnAl-LDH and **preserves their antibacterial activity** as the nanocomposite produces a similar inhibition zone to the pure drug.

https://sciforum.net/event/IOCM2025