TURNING WASTE INTO LIFESAVING CARBON:
HIGH-PERFORMANCE ADSORBENTS FOR DRUG DETOXIFICATION

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7th Commonwealth Chemistry Posters
24 – 25 June 2026

Addresses pharmaceutical contamination in water

Converts low-value waste into high-value adsorbent

High adsorption capacity and fast kinetics

Excellent stability and reusability

Supports UN SDGs 3, 6, 12, 13

1 Background

- Activated carbon (AC) is widely used for emergency drug detoxification due to its high adsorption capacity.
- Conventional AC production relies on costly precursors and energy-intensive processes.
- Bakery oven fly ash (BOFA) is a carbon-rich waste with potential for sustainable adsorbent production.
- This study converts BOFA into high-performance activated carbon for pharmaceutical adsorption.

2 Problem

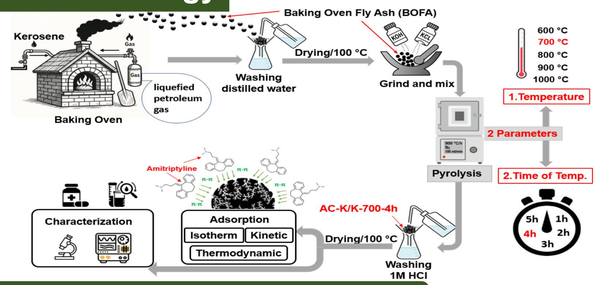
- Most fly ash-derived carbons exhibit limited surface area and adsorption performance.
- The synergistic role of KOH/KCl dual activation in tailoring pore architecture remains poorly understood.
- The influence of pyrolysis temperature and residence time on pharmaceutical adsorption has not been systematically investigated.
- Gap: A mechanistic understanding of how activation conditions control pore development and drug adsorption is still lacking.

3 Aim

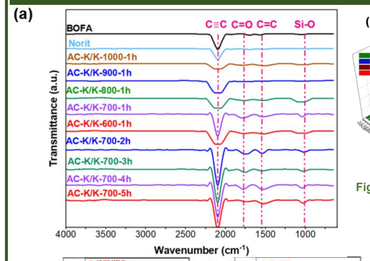
- Develop high-performance activated carbon from bakery oven fly ash using KOH/KCl dual activation.
- Investigate the effect of pyrolysis temperature (600–1000°C) and time (1–5 h).
- Establish structure–function relationships governing adsorption performance.
- Evaluate amitriptyline detoxification under simulated gastric and intestinal conditions..

SCAN ME for full paper & supplementary data

4 Methodology



5 Results & Characterization



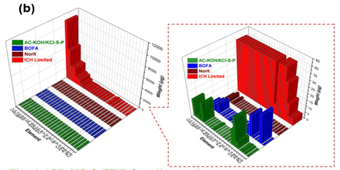


Fig. 1 ICP-MS & FTIR for all samples

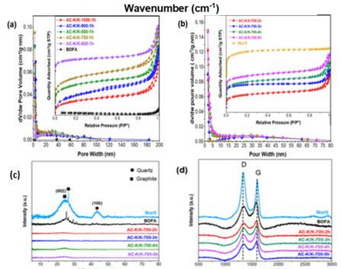


Fig. 2 (a, b) BET (c, d) XRD and Raman for all samples

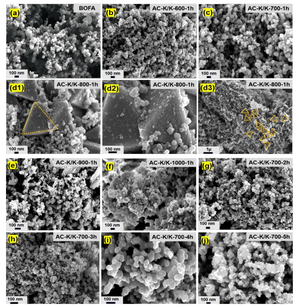


Fig. 3 FESEM and particle size distribution for all samples

6 RESULTS&ADSORPTION STUDIES (Isotherm, Kinetics, Thermodynamics)

Freundlich isotherm and PFO kinetics confirmed efficient spontaneous adsorption under simulated gastric and intestinal conditions.

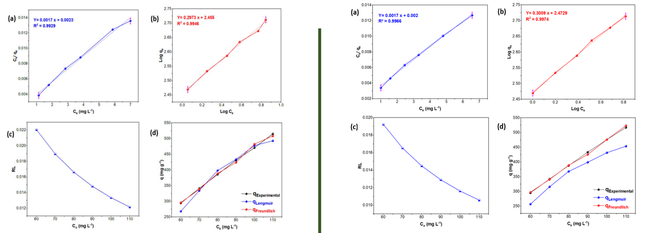


Fig. 4. Adsorption isotherm models in SGF.

Fig. 5. Adsorption isotherm models in SIF.

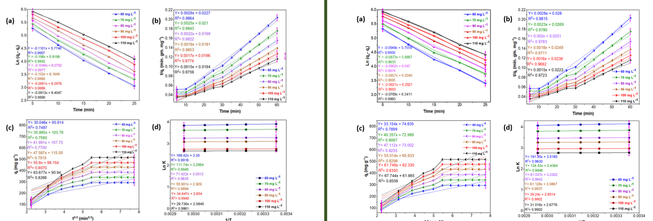


Fig. 6. (a) PFO kinetic plot, (b) PSO kinetic plot, (c) Intraparticle diffusion, (d) van't Hoff plot for AMI·HCl adsorption on AC-K/K-700-4h in SGF conditions.

Fig. 7. (a) PFO kinetic plot, (b) PSO kinetic plot, (c) Intraparticle diffusion, (d) van't Hoff plot for AMI·HCl adsorption on AC-K/K-700-4h in SIF conditions.

MAXIMUM ADSORPTION CAPACITY: 470-476 mg g^{-1}

Table 3. Key Adsorption Performance Indicators

Adsorption	SGF	SIF
qMax (mg g^{-1})	476	470
Removal (%)	98-99	97-98
Best Isotherm	Freundlich	Freundlich
Best Kinetic	PFO	PFO
ΔH° (kJ mol^{-1})	-48	-46

7 MECHANISM OF ADSORPTION

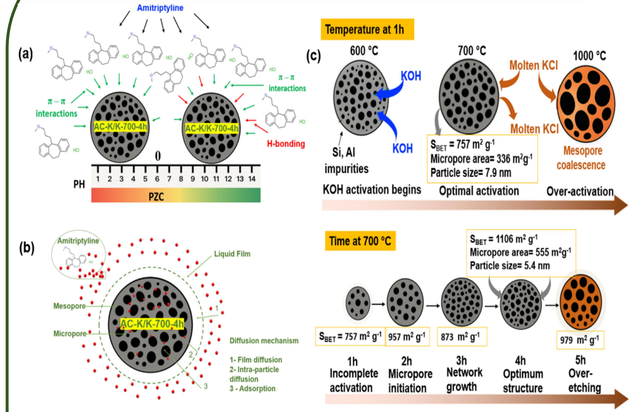


Fig. 8 Proposed adsorption mechanism and pore evolution during KOH/KCl activation. KOH generates micropores, while KCl promotes mesopore development and structural stability. The optimized carbon (700 °C, 4 h) exhibits a hierarchical pore network that enhances amitriptyline diffusion, pore filling, and adsorption under physiological conditions.

8 CONCLUSION & HIGHLIGHTS

- ✔ 700 °C, 4 h optimum activation
- ✔ 1106 m^2 g^{-1} surface area
- ✔ 470–476 mg g^{-1} adsorption capacity
- ✔ 98–99% removal efficiency
- ✔ ~90% capacity retained after 5 cycles

9 ACKNOWLEDGMENT

The authors would like to acknowledge the grant funding provided by the Universiti Kebangsaan Malaysia, Malaysia, under the Geran Universiti Penyelidikan (GUP) (Project Number: DIP-2023-014). They are also grateful for the technical and management support from the Centre for Research and Instrumentation (CRIM) at the Universiti Kebangsaan Malaysia.

Keywords:
Activated carbon | Fly ash | KOH/KCl activation | Amitriptyline | Adsorption | Drug detoxification | Waste valorization

Towards Clean Water & Better Health for All