INTERNATIONAL ISLAMIC
UNIVERSITY MALAYSIA

DYE REMOVAL FROM WASTEWATER USING *MORINGA OLEIFERA* SEED SHELLS BASED ADSORBENT

Presentation for ICCHES 2023

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Would YOU drink it?

Introduction

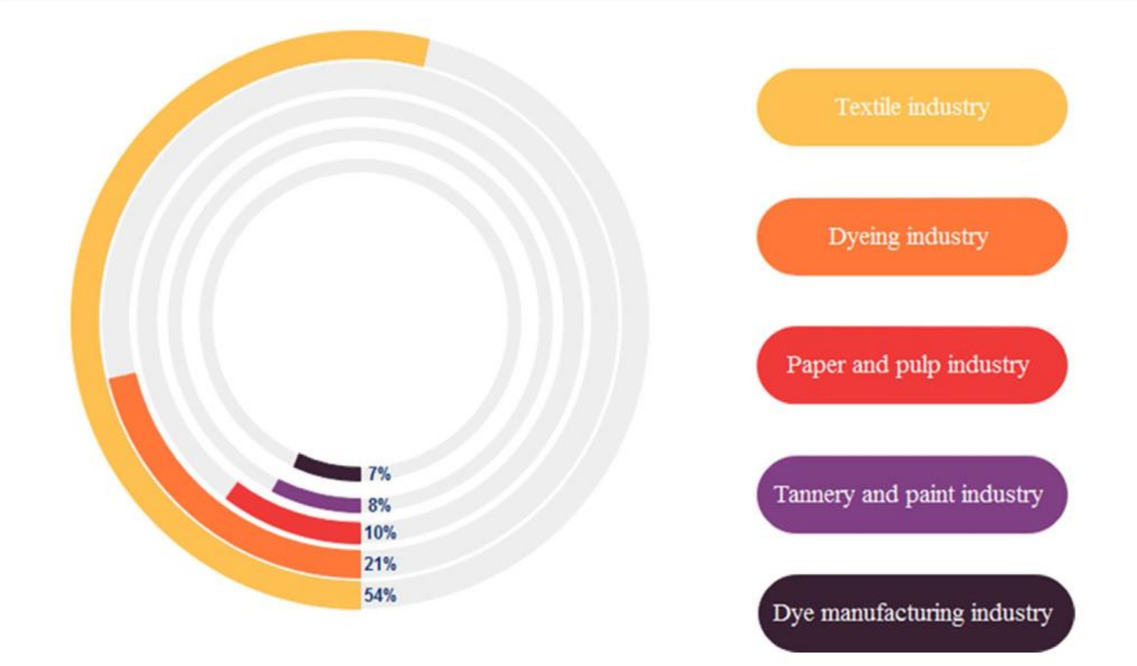


Figure 1: Major industries that are causing the release of dyes in the environment (De Gisi et al., 2016).

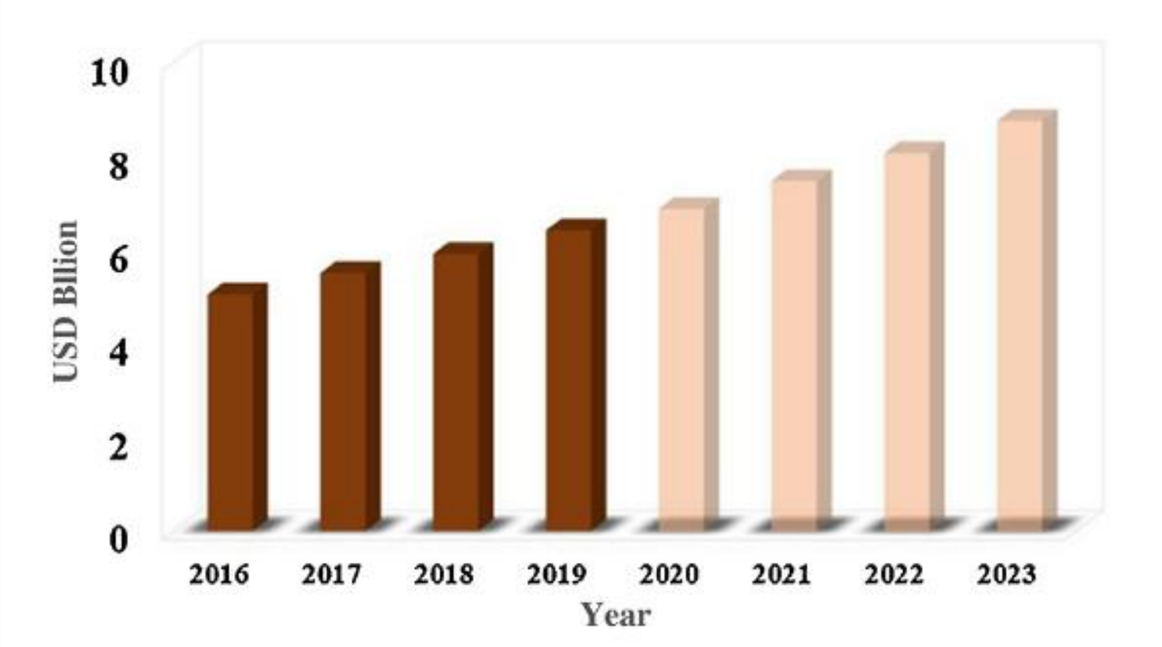


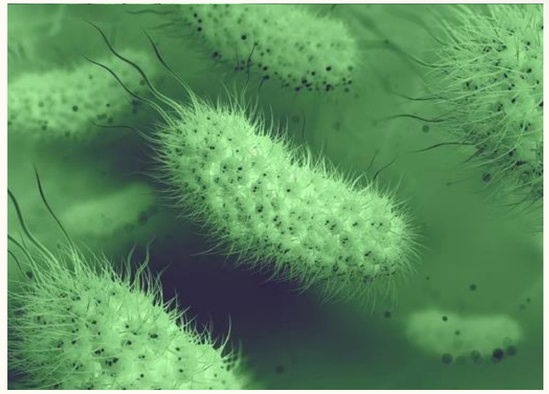
Figure 2: The global textile dyes market over the forecasted period of 2016–2023 (Samsami et al., 2020).

Ecological Risks

Plants

Aquatic animals

Humans & Animals



Aquatic microorganisms

Source: Mustafa et al. (2014)

Pinpointing the Problem

Limited success of current dye treatment technologies such as cost, efficiency and feasibility hence **alternating to green technologies** in assuring the wastewater released by industries are **within the regulations.**

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One man's waste is another man's treasure.

- Sustainability
- High treatment efficiency
- Availability
- Diversity of active site
- Profitability

Source: Asmaa et al. (2022)

Objectives

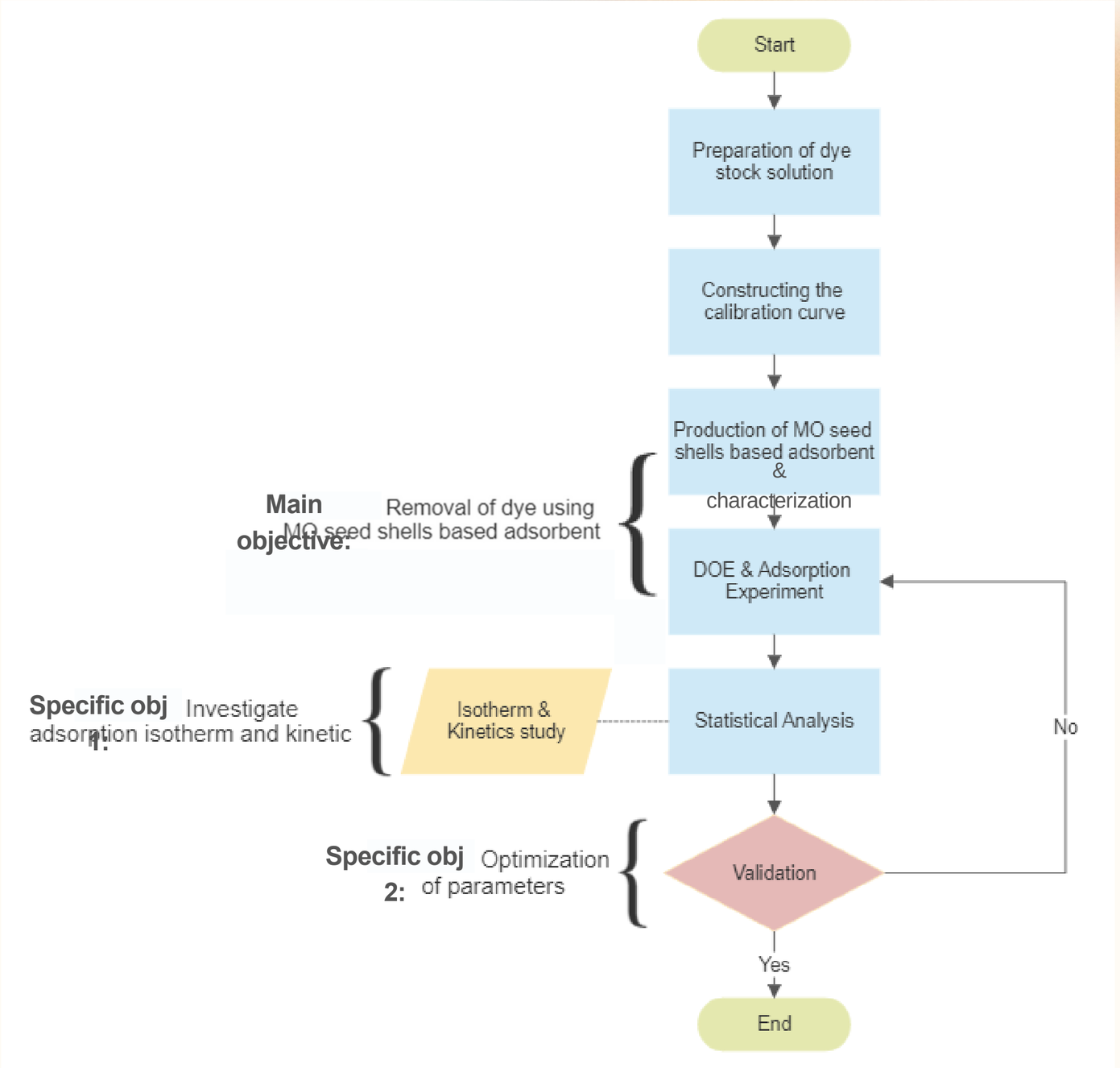
Main objective

Effectively & efficiently remove dyes using MO seed husks based adsorbent and to perform characterization

Specific objectives

- To optimize adsorption process parameters on dye removal (pH, dose, time)
- To investigate the adsorption isotherms and kinetics

Overall flowchart



Methodology

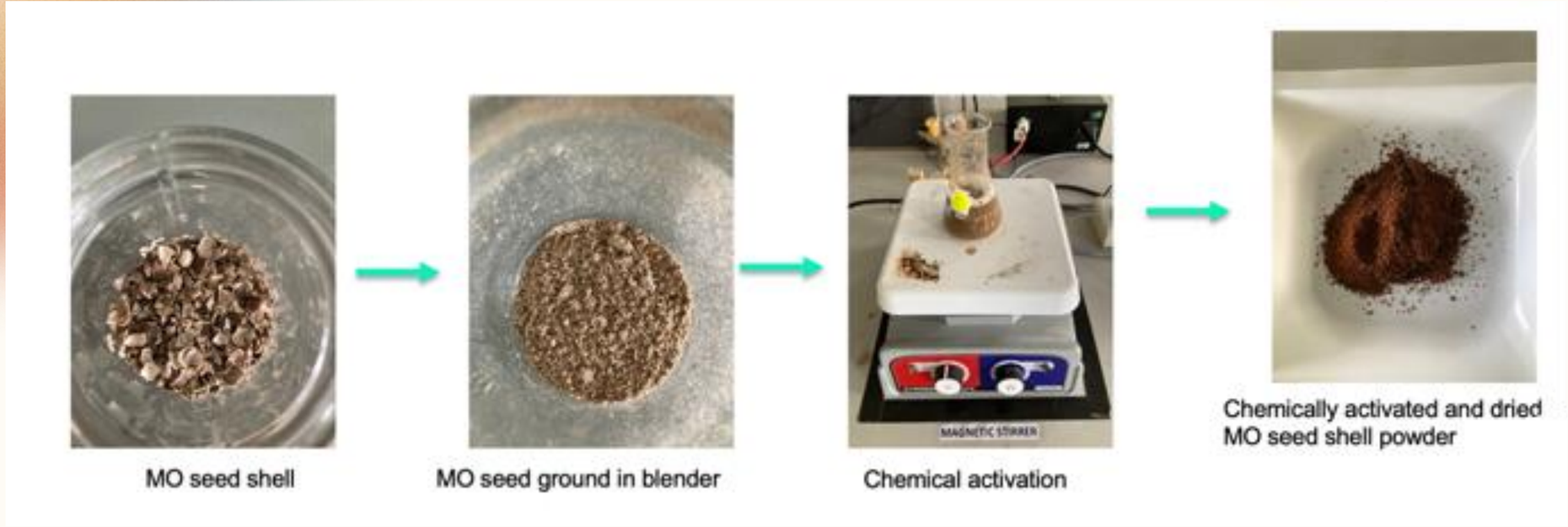


Figure 3: Chemical activation steps

Methodology

Figure 4: Thermal activation steps

Experimental steps

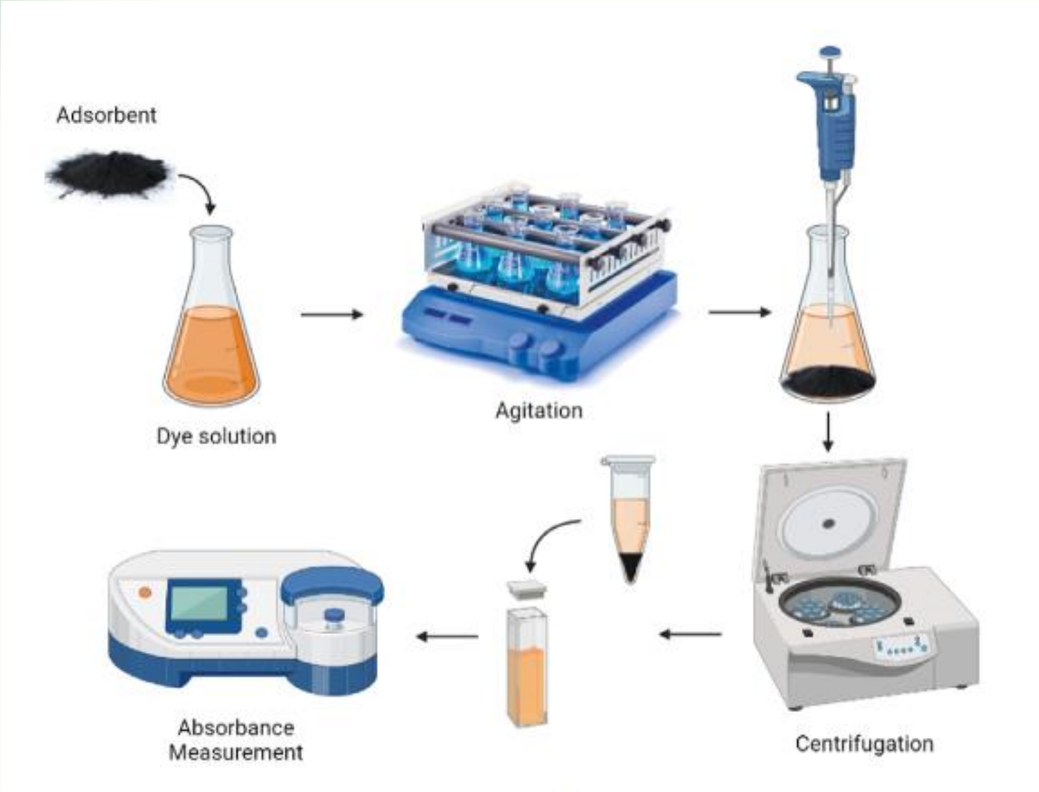


Figure 5: Schematic representation of the adsorption experiment (Khalfaoui et al., 2022)

Results

Fourier Transform Infrared Spectroscopy (FTIR) Analysis

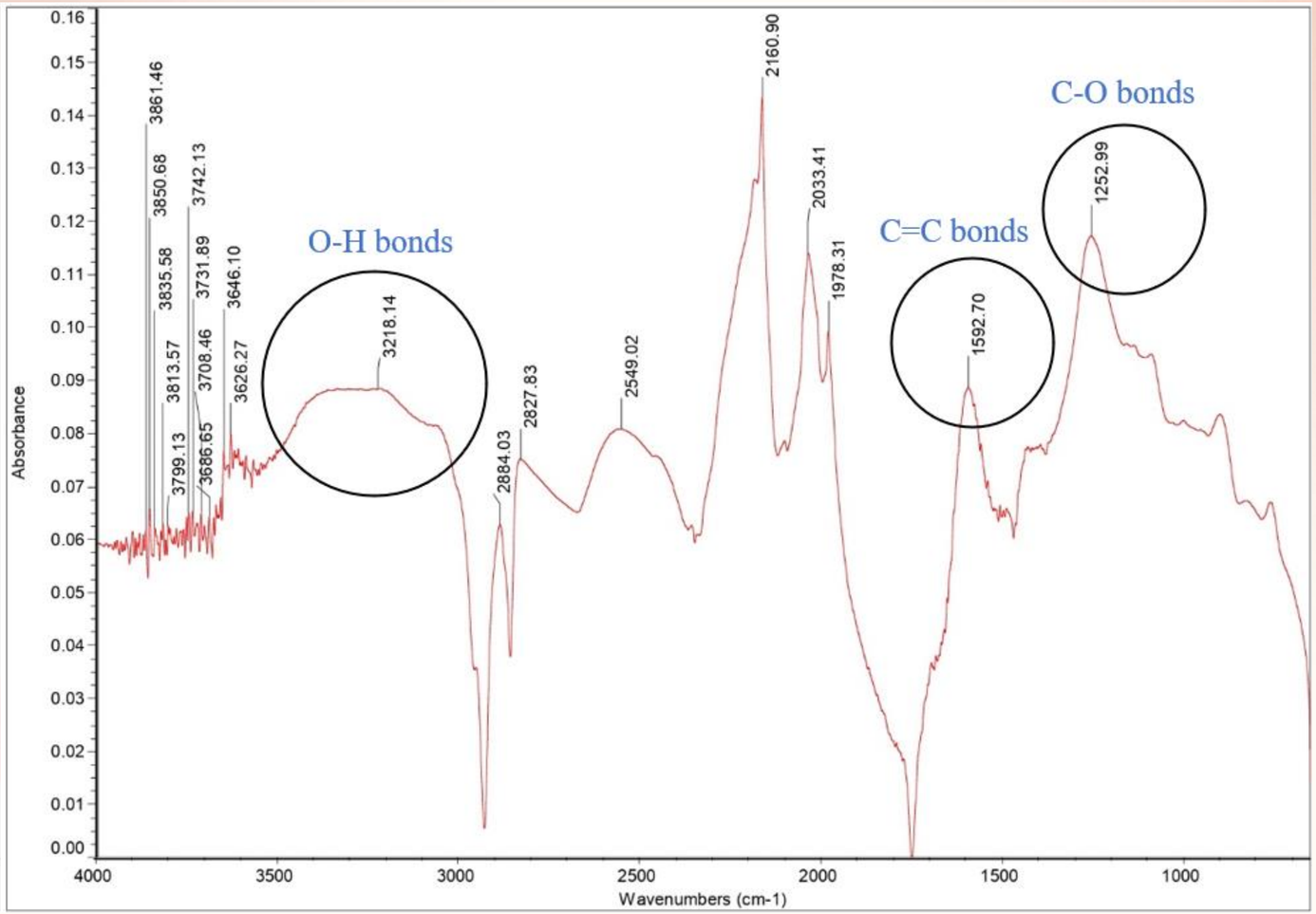


Figure 6: Infrared spectra of MO seed husk as activated carbon (AC)

Results

Scanning Electron Microscopy (SEM) images

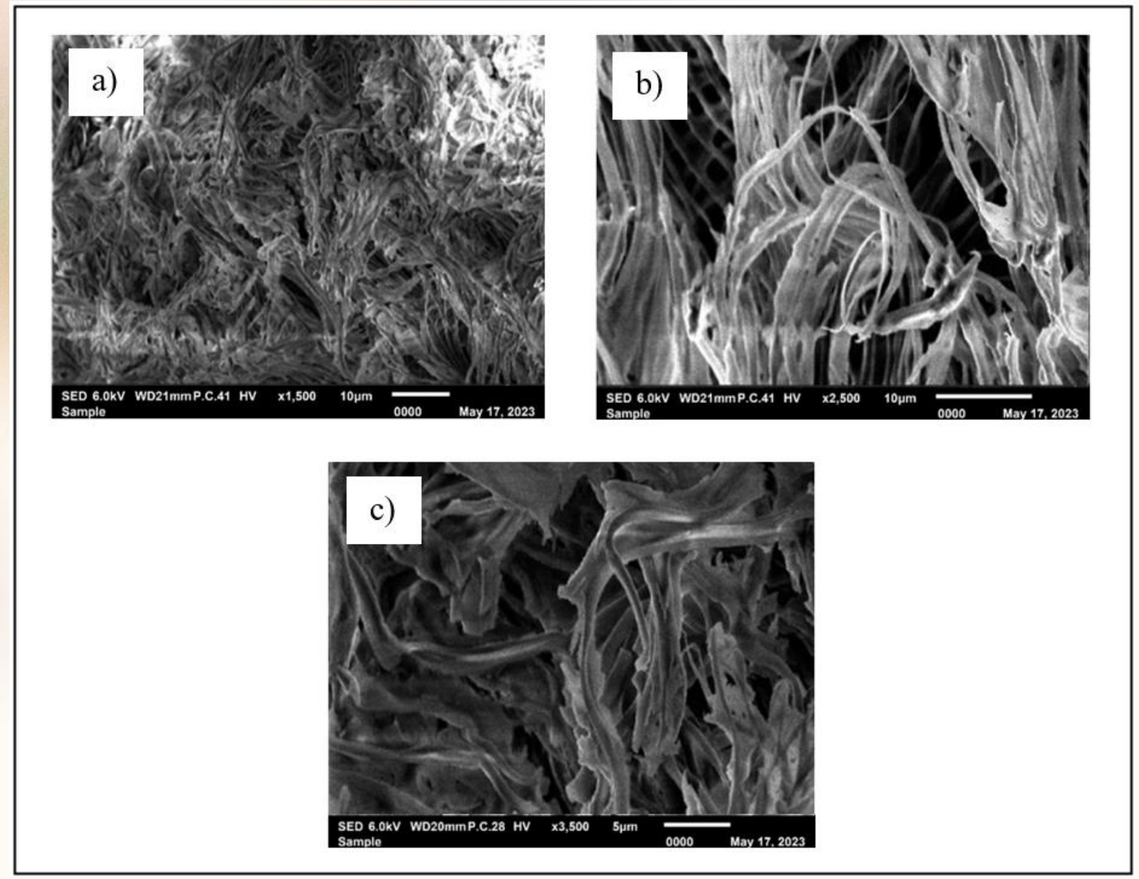


*Figure 7: Scanning Electronic Micrographics (SEM) of **raw** Moringa Oleifera seed husk powder (a) at x1,500 (b) at x2,500 (c) at x3,500*

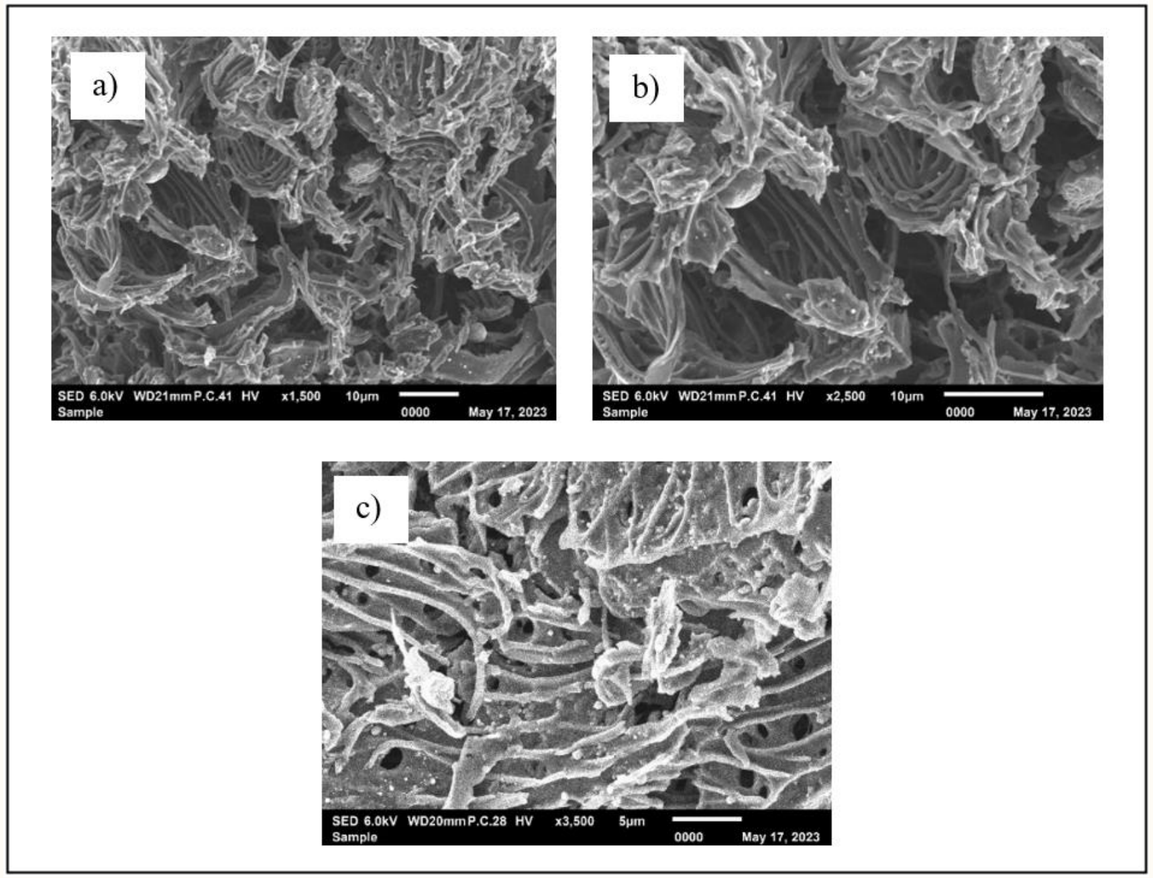


*Figure 8: Scanning Electronic Micrographics (SEM) of MO seed husk-based **activated carbon** (a) at x1,500 (b) at x2,500 (c) at x3,500*

Results

Design of Experiment (DoE)

- Response Surface Methodology based on Face Centered Central Composite Design (FCCCD)

Factor ranges:

- pH: **4 – 10**
- Adsorbent dose: **0.025g – 0.125g**
- Contact time: **30 – 70 minutes**

Response:
Removal percentage of methylene blue (MB):

$$Removal\ (\%) = \frac{C_0 - C_f}{C_0} \times 100$$

Table 1: Removal efficiency of methylene blue for 20 runs of experiments

Run	pH	Adsorbent dose (g)	Time (min)	Absorbance	Final conc. (mg/L)	Removal efficiency (%)
1	7	0.075	50	1.583	12.18	18.77
2	4	0.125	30	1.571	12.08	19.44
3	4	0.025	70	1.261	9.50	36.66
4	4	0.075	50	1.616	12.46	16.94
5	7	0.075	50	1.569	12.07	19.55
6	7	0.125	50	1.463	11.18	25.44
7	10	0.075	50	1.512	11.59	22.72
8	10	0.075	70	1.670	12.91	13.94
9	4	0.075	30	1.719	13.32	11.22
10	10	0.075	30	1.701	13.17	12.22
11	7	0.075	50	1.586	12.21	18.61
12	10	0.125	30	1.278	9.64	35.72
13	7	0.075	70	1.351	10.25	31.66
14	10	0.125	70	1.240	9.33	37.83
15	7	0.075	30	1.513	11.60	22.66
16	7	0.075	50	1.763	13.68	8.77
17	7	0.075	50	1.605	12.37	17.55
18	7	0.075	50	1.661	12.83	14.44
19	4	0.125	70	1.315	9.95	33.66
20	7	0.075	50	1.598	12.31	17.94

Results

Design of Experiment (DoE)

*Figure 9: Sample **before** adsorption process*

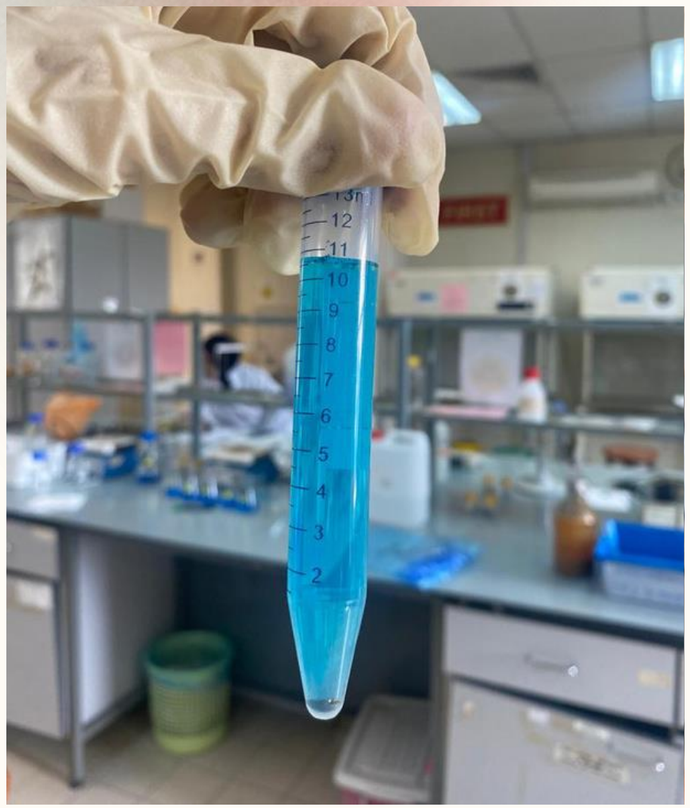


*Figure 10: Sample **after** adsorption process*

Results

Optimization and model validation

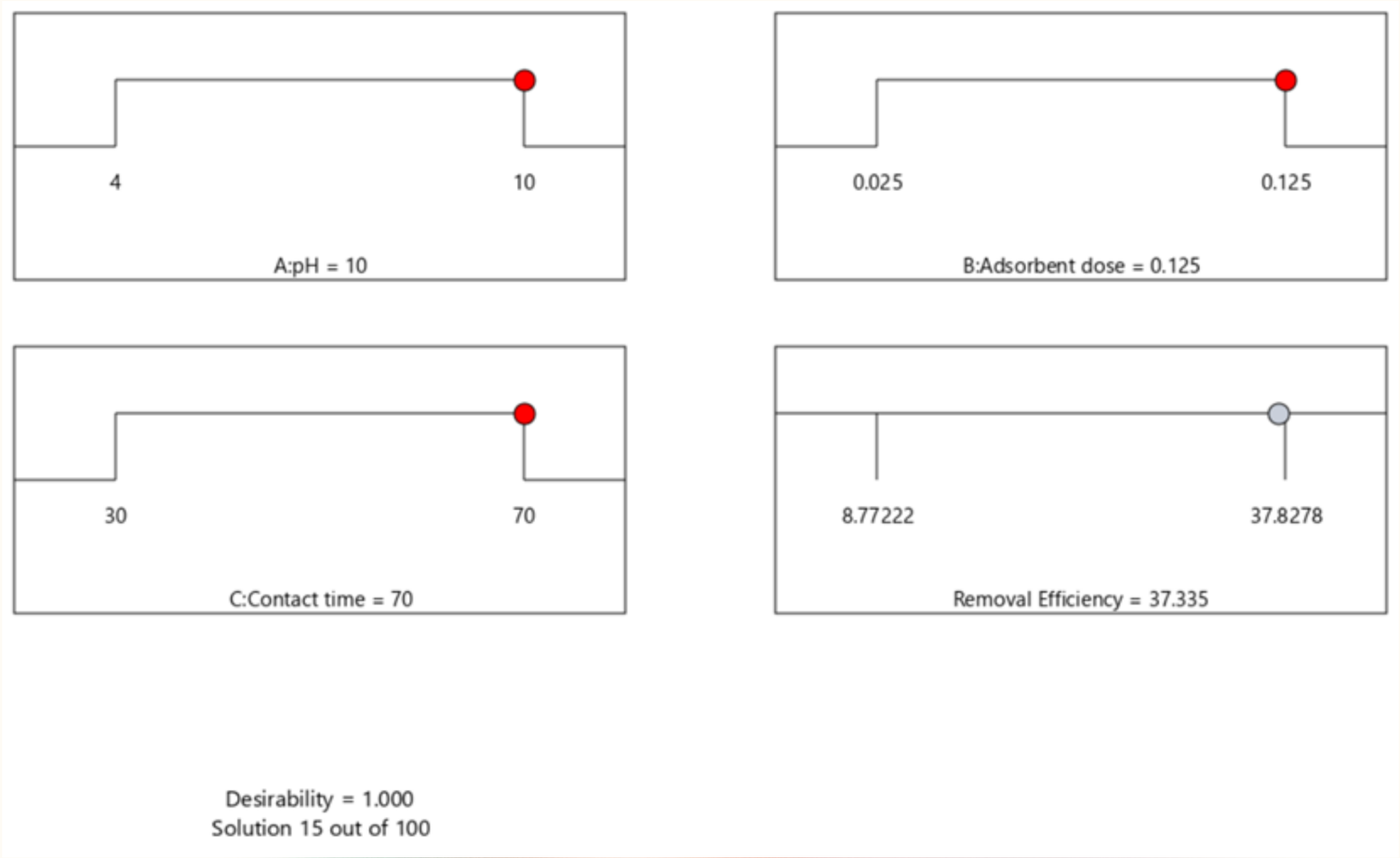


Figure 11: The desirability effect for MB adsorption on MO seed husk-based adsorbent

Results

Isotherm Study

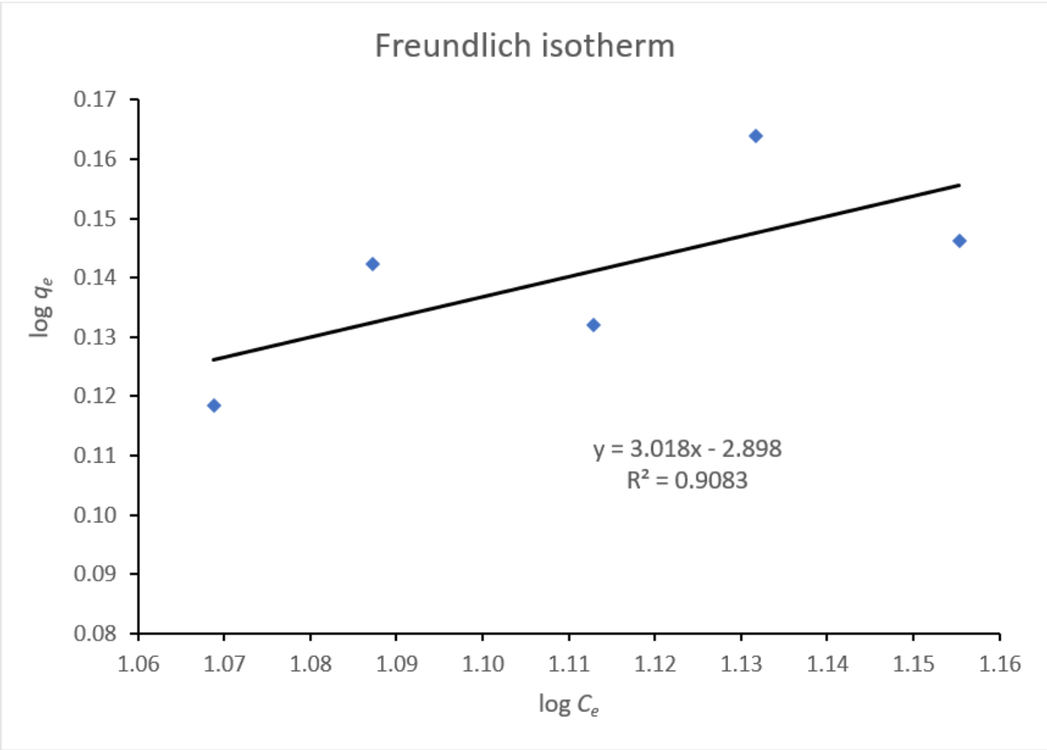


Figure 12: The plot of Freundlich model

Table 2: Estimated isotherm parameters

Isotherm model	Langmuir			Freundlich		
Estimated isotherm parameters	q_{max}	K_L	R^2	$1/n$	K_f	R^2
	-1.2143	-0.054	0.938	0.3313	0.0126	0.9083

Freundlich Model

Isotherm Study

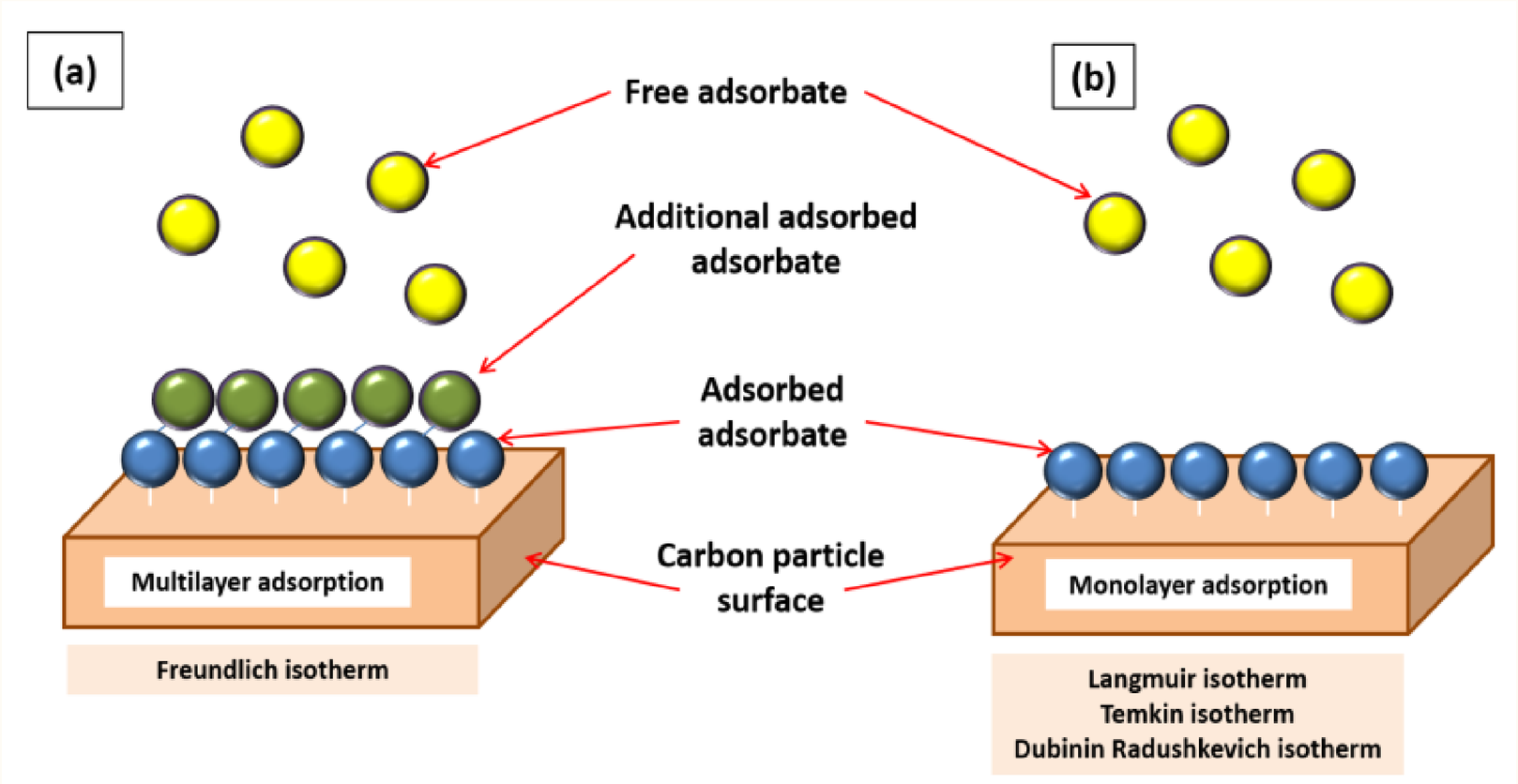


Figure 13: Illustration of adsorption profile in multilayer (a) and monolayer (b) types (Nandiyanto et al., 2020)

Results

Kinetics Study

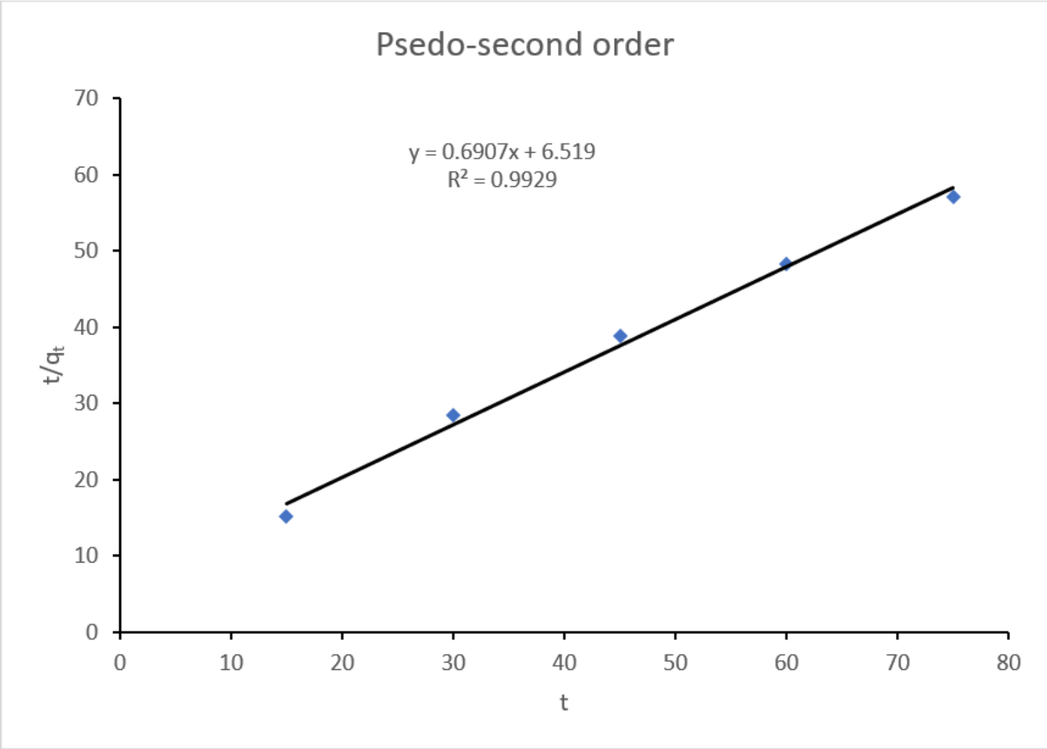


Figure 14: The plot of pseudo-second order kinetic model

Table 3: Estimated kinetics parameters

Kinetics model	Pseudo-first order			Pseudo-second order		
Estimated kinetics parameters	q_e	k_1	R^2	q_e	k_2	R^2
	4.819	0.102	0.6914	21.72	0.00032	0.9929

Conclusion & Future Work

The study employed a comprehensive approach, combining various analytical techniques and statistical analysis to evaluate the adsorbent's performance. All objectives are **achieved**.

Future Works:

- Investigating **reusability** of adsorbent
- Application on **real wastewater** samples
- Alternative chemical **activating agent**

Q&A Session

Thank you for listening!