

**ADSORPTION BEHAVIOR OF PALM OIL EMPTY FRUIT BUNCH
ACTIVATED CARBON BY PHOSPHORIC ACID IMPREGNATION
ACTIVATION**

SITI NUR ATHIRA BINTI ABDUL AZIZ

**Final Year Project Proposal Submitted in
Partial Fulfilment of the Requirements for the
Degree of Bachelor of Science (Hons.) Applied Chemistry
in the Faculty of Applied Sciences
Universiti Teknologi MARA**

JULY 2025

This Final Year Project Report entitled “Adsorption Behavior of Palm Oil Empty Fruit Bunch Activated Carbon by Phosphoric Acid Impregnation Activation” was submitted Siti Nur Athira Binti Abdul Aziz in partial fulfilment of the requirements for the Degree of Bachelor of Science (Hons.) Applied Chemistry, in the Faculty of Applied Sciences, and was approved by

En. Mohd Fauzi bin Abdullah
Supervisor
B. Sc. (Hons.) Applied Chemistry
Faculty of Applied Sciences
Universiti Teknologi MARA
02600 Arau
Perlis

Madam Farhana Binti Othman
Project Coordinator
B. Sc. (Hons.) Applied Chemistry
Faculty of Applied Sciences
Universiti Teknologi MARA
02600 Arau, Perlis

Dr. Nur Nasulhah Binti Kasim
Head of Programme
B. Sc. (Hons.) Applied Chemistry
Faculty of Applied Sciences
Universiti Teknologi MARA
02600 Arau, Perlis

Date : _____

ABSTRACT

Adsorption Behavior of Palm Oil Empty Fruit Bunch Activated Carbon by Phosphoric Acid Impregnation Activation

The discharge of synthetic dyes such as methylene blue (MB) into water sources poses serious environmental concerns due to their toxicity and resistance to degradation. Conventional wastewater treatment methods often face limitations in effectively removing these pollutants. This study aimed to develop a low-cost and sustainable adsorbent using palm oil empty fruit bunch (POEFB), an abundant agricultural waste in Malaysia, for the removal of MB from wastewater. POEFB was converted into activated carbon through carbonization at 600 °C followed by phosphoric acid impregnation to enhance its porosity and surface area for adsorption applications. The produced activated carbon was characterized using FTIR analysis, iodine number, ash and moisture content, bulk density, and pH_{pzc} measurements to evaluate its physicochemical properties. Batch adsorption experiments were conducted to examine the effects of initial dye concentration, adsorbent dosage, and contact time on MB removal efficiency. The activated carbon exhibited a high iodine number of 1189.57 mg/g, low ash content of 2.50%, moisture content of 6.18%, and a pH_{pzc} of 4.3. The highest removal efficiency achieved was 99.87% at 200 mg/L MB concentration, 1.0 g adsorbent dosage, and 180 min. of contact time. These findings demonstrate that POEFB-derived activated carbon is an effective, low-cost, and sustainable adsorbent for the removal of MB dye from wastewater, supporting waste valorisation within the palm oil industry while addressing environmental pollution concerns.

TABLE OF CONTENTS

	Page
ABSTRACT	I
ABSTRAK	II
ACKNOWLEDGEMENT	III
TABLE OF CONTENTS	IV
LIST OF TABLES	VII
LIST OF FIGURES	VIII
LIST OF SYMBOLS	IX
LIST OF ABBREVIATIONS	X
CHAPTER 1	1
INTRODUCTION	1
1.1 Research Background	1
1.2 Problem Statement	3
1.3 Research Questions	4
1.4 Objectives	4
1.5 Significance of study	4
1.6 Expected Output	5
CHAPTER 2	7
2.1 Dyes	7
2.1.1 Methylene Blue Dye	8
2.2 Production of Activated Carbon	10
2.2.1 Palm oil Empty Fruit Bunches	10
2.2.2 Activated Carbon	12
2.2.3 Empty Fruit Bunches as Activated Carbon	13
2.3 Enhancement of Adsorption Performance	15

2.3.1	Impregnation Activation	15
2.3.3	Phosphoric acid activation	16
CHAPTER 3		20
3.1	Material and chemical	20
3.2	Equipment and instrument	21
3.3	Method and procedure	22
3.3.1	Preparation of activated carbon	22
3.3.2	Adsorption Experiments to characterize palm oil empty fruit bunch (POEFB)	23
3.3.2.1	Moisture content	23
3.3.2.2	Ash Content	24
3.3.2.3	pH at zero point charge (pHpzc)	25
3.3.2.4	Iodine test	25
3.3.2.5	Bulk Density	26
3.3.3	Adsorption of methylene blue	26
3.3.3.1	Effect adsorbent dosage	27
3.3.3.2	Effect of contact time	28
3.3.3.3	Effect of initial concentration of methylene blue dye	28
3.3.4	Fourier Transform Infrared Spectroscopy (FTIR) analysis	29
CHAPTER 4		31
RESULT & DISCUSSION		31
4.1	Introduction	31
4.2	Percentage yield of Activated Carbon	31
4.3	Physicochemical properties of POEFB-AC	32
4.3.1	Ash content	33
4.3.2	Moisture content	34
4.3.3	Iodine number	35
4.3.4	Bulk density	37
4.4	pH at point zero charge	38
4.5	FTIR Analysis	39
4.6	Adsorption of methylene blue	42
4.6.1	Calibration curve	42
4.6.2	Adsorbent dosage	43
4.6.3	Contact time	45
4.6.4	Effect of Initial Methylene Blue Concentration	47
CHAPTER 5		50
CONCLUSION AND RECOMMENDATIONS		50