

UNIVERSITI TEKNOLOGI MARA

**COAGULATION – FLOCCULATION
AND PERFORMANCE
EVALUATION OF
HYLOCEREUS UNDATUS
(WHITE DRAGON FRUIT) FOLIAGE
AS A NATURAL COAGULANT FOR
PAINT WASTEWATER
TREATMENT**

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Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science
(Chemical Engineering)

College of Engineering

July 2023

ABSTRACT

Towards exploring the application of natural coagulants in industrial wastewater treatment, plant-based coagulants have been gaining more interests due to its potentials such as biodegradability and easy availability. *Hylocereus undatus* foliage as the plant-based coagulant has been proven to be efficient during the coagulation – flocculation process; however, limited research has been reported focusing only on palm oil mill effluent (POME) and latex concentrate wastewater. In addition, limited study has been carried out to determine the performance evaluation of *H.undatus* foliage in treating different types of wastewaters incorporating different operating conditions using optimization techniques. Hence, this study employed response surface methodology (RSM) in an attempt to determine the performance evaluation of the coagulant in paint wastewater treatment, its characterization, and the mechanism that prompts the coagulation – flocculation process. The standard jar test method was utilized in investigating the effect of pH value, coagulant dosage, rapid mixing speed and temperature as the operating conditions on turbidity, chemical oxygen demand (COD) and suspended solids (SS). Through central composite design (CCD) via Design Expert software, the optimum conditions were achieved at pH 5, coagulant dosage of 300 mg/L, rapid mixing speed of 120 rpm and temperature at 30°C. The experimental data was observed to be close to the model predictions with the optimum turbidity, COD and SS removal efficiencies at 62.81%, 59.57% and 57.23%, respectively. Rather, the final turbidity, COD, and SS are 28,700, 36,000, and 680 mg/L, respectively. The increase of the zeta potential value from – 21.9 to – 1.33 experienced by the paint wastewater and the recovered sludge at optimum condition demonstrated the effectiveness of *H.undatus* foliage, with magnitude charge of +1.03mV, as perceived of possessing sufficient H⁺ ions, typically in cationic coagulants, in prompting charge neutralization mechanism during coagulation process. Moreover, the FTIR spectroscopy disclosed the presence of carbonyl, carboxyl, amides, and amines groups which contributed to both particle bridging and charge neutralization mechanisms. Meanwhile, SEM-EDX analysis showed rough and porous structure of the foliage which was suitable for the coagulation – flocculation process. The foliage contained 68.95% of carbon composition that acts as a binding agent, and metallic compounds like potassium, calcium, magnesium, and aluminium. Thermographic profiles analysis revealed that two distinctive zones were observed for the *H.undatus* foliage and the sludge, indicating the degradation of carbohydrates and lipids in the first zone at 0.45 mg/min followed by the degradation of proteins in the second zone at 0.035mg/min. However, a single degradation zone was observed for the raw paint wastewater, indicating protein degradation. This indicates that adsorption mechanism during the process, supported by the high BET surface area of 0.5882 m²/g from the foliage significantly provides the availability of higher concentration of adsorption sites for the coagulation-flocculation process. In conclusion, *H.undatus* foliage demonstrated cationic coagulants behaviour and has further proven its efficiency as a natural coagulant in treating paint wastewater.

ACKNOWLEDGEMENT

First and foremost, all praises to Allah for this given opportunity to embark on my master's degree despite the challenging journey and being able to pull through even with the COVID-19 outbreak. It was only possible for me to successfully complete this thesis with endless support of the kind people around me. Furthermore, I would like to express my utmost gratitude and thanks to my main supervisor, Prof Dr Ayub bin Md Som as the completion of this thesis is made possible with his supervision, advice, support, and the incomparable knowledge throughout this experience. The good advice and guidance of my co-supervisor, Dr Siti Wahidah binti Puasa also have been very valuable on many levels. In addition, I would also like to extend my gratefulness to ChM Dr Hairul Amani binti Abdul Hamid from the Faculty of Applied Sciences for her expertise and wisdom especially regarding the later part of the research, enabling me to conclude my objectives. Moreover, a token of appreciation is dedicated particularly to the School of Chemical Engineering and Institute of Science of UiTM Shah Alam for providing ample assistance and conducive facilities and analytical equipment in conducting the experimental runs and analyses required in achieving the purposes of this study. Last but not least, I would also express my appreciation to my family members, especially to my mother Masnida for the many levels of support and prayers for the strength and motivation in eventually completing this thesis.

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