
**UNIVERSITI PUTRA MALAYSIA**

# *JATROPHA CURCAS* L. AS POTENTIAL BIO-COAGULANT FOR WASTEWATER TREATMENT

**NORHAFIZA BINTI MADEHI**

**FK 2013 77**

# JATROPHA CURCAS L. AS POTENTIAL BIO-COAGULANT FOR WASTEWATER TREATMENT

**By**

**NORHAFIZA BINTI MADEHI**

**Thesis Submitted to the school of Graduate Studies, Universiti Putra Malaysia In**

**Fulfillment of the Requirement for the Degree of Master of Science**

**February 2013**

**Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science**

# *JATROPHA CURCAS* L. AS POTENTIAL BIO-COAGULANT FOR WASTEWATER TREATMENT

**By**

**NORHAFIZA BINTI MADEHI**

**February 2013**

**Chair: Zurina Zainal Abidin, PhD**

**Faculty: Engineering**

This project aims to investigate the potential use of *Jatropha Curcas* (JC) as a bio-coagulant in wastewater treatment. The first objective of this study was to investigate the performance of JC for its potential use as a bio-coagulant compared to alum. Palm Oil Mill Effluent (POME) is wastewater generated from the palm oil milling industry. It is a highly polluted wastewater which contains high Chemical Oxygen Demand (COD), typically averaging from 30,000 to 43,700 mg/L, with Biological Oxygen Demand (BOD), from 20,000 to 30,000 mg/L and Total Suspended Solids (TSS) from 18,000 to 18,500 mg/L. It is acidic in pH ranging from pH 4.6 to 4.8 and brownish in colour. When freshly discharged, POME has a temperature of between 80 and 90$^{o}$C. POME consists of a high volume of liquid waste which is non-toxic but has an unpleasant odour, and must be treated properly before being discharged into the environment. The use of inorganic coagulants like alum has led to the spread of chronic diseases due to the residual content of the coagulants in the treated wastewater. Thus, this study searched for an alternative using JC plant, a bio-resource. Coagulation and flocculation methods were used in this study.

In this study, the optimum condition for synthetic water kaolin treatment was at pH 2, with a dosage of 120 mg/L, and with 99% turbidity removal. It was found that JC presscake showed better coagulation performance compared to JC seed coagulant, with 99% turbidity removal at an optimum pH of 3 and 140 mg/L dosage concentration. JC seeds, on the other hands, showed the potential to remove about 93% turbidity at the optimum of pH of 3 and with 120 mg/L dosage. Furthermore, the performance of JC as a bio-coagulant was compared to aluminum sulphate (alum) coagulant. The results showed that alum gave 93% turbidity removal at optimum pH 5 and with an optimum dosage of 1200mg/L. The treatment of POME wastewater by using JC presscake as a bio-coagulant was successfully able to reduce COD with up to 70% in value, 65% of BOD reduction and 88% of TSS removal, whereas alum coagulant resulted in 59% of COD, 61% of BOD reduction and 71% of TSS removal.

The second objective of this study was to examine the characterization of the composition of JC seed and JC presscake as potential coagulant agents for wastewater treatment by using High Performances Liquid Chromatography (HPLC) analysis. The results showed that 18 types of amino acid were detected. The amino acid Lysine was detected to have the highest composition in JC seed with 24.87%, followed by the amino acid, Cystine, with 21.74% in composition. JC presscake, on the other hand, had the highest composition for the amino acid Phenylalanine with 15.34%, followed by the amino acid Cystine with 14.21%.

For the third objective of this study, a final quantitative analysis through HPLC was conducted. The final treated POME was run through HPLC analysis to detect the presence of *Phorbol-esters.* The peaks indicated that there was no *Phorbol-ester* in the treated wastewater solution.

As a conclusion, this study has proven that JC presscake has a high potential to be used as a bio-coagulant for wastewater treatment. The estimated cost for treatment using JC seed was

RM 0.035 per 1 liter of wastewater treated. JC presscake coagulant is cheaper than JC seed kernel coagulant if JC presscake coagulant can be directly obtained from the industry's extraction process of *Jatropha* oil.

**Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains**

**JATROPHA CURCAS L. SEBAGAI POTENSI BAHAN PENGGENTAL SEMULAJADI BAGI PERAWATAN AIR SISA**

**Oleh**

**NORHAFIZA BINTI MADEHI**

**Februari 2013**

**Pengerusi: Zurina Zainal Abidin, PhD**

**Fakulti: Kejuruteraan**

Projek ini bertujuan untuk mengkaji potensi penggunaan tumbuhan *Jatropha curcas* (JC) sebagai agen bio-penggental dalam rawatan air sisa. Objektif pertama kajian ini adalah untuk mengkaji potensi JC untuk digunakan sebagai bio-penggental. Air sisa minyak sawit (POME) adalah air sisa yang dijana daripada industri pengilangan minyak kelapa sawit. Ia adalah sisa air yang sangat tercemar yang mengandungi permintaan kimia yang tinggi (COD), biasanya purata dari 30,000 hingga 43,700 mg / L, permintaan oksigen biokimia (BOD), daripada 20,000 hingga 30,000 mg / L dan jumlah pepejal terampai (TSS) daripada 18,000 hingga 18,500 mg / L. Air sisa ini adalah berasid dan mempunyai pH antara pH 4.6-4.8 dan bewarna coklat. Air sisa POME yang baru dilepaskan mempunyai suhu antara 80 dan 90$^{o}$C. Air sisa POME ini mengandungi jumlah pepejal terampai yang tinggi dan sisa cecair yang bukan toksik tetapi mempunyai bau yang tidak menyenangkan, dan mesti dirawat dengan sebaiknya sebelum dilepaskan ke dalam alam sekitar. Penggunaan pengental bukan organik seperti tawas telah membawa kepada penyebaran penyakit kronik akibat kesan kandungan sisa bagi bahan penggental dalam air sisa yang dirawat. Oleh itu, kajian ini mencari alternatif

menggunakan tumbuhan JC sebagai sumber semulajadi. Kaedah penggumpalan dan penggentalan telah digunakan dalam kajian ini.

Dalam kajian ini, keadaan optimum untuk rawatan air sintetik kaolin adalah pada pH 2, dengan dos sejumlah 120 mg / L, dan dengan 99% penyingkiran kekeruhan. Ia telah menunjukkan hampas JC memberikan prestasi sebagai bahan penggentalan yang lebih baik berbanding dengan penggental benih JC, dengan 99% penyingkiran kekeruhan pada pH optimum 3 dan 140 mg / L kepekatan dos. Penggental benih JC menunjukkan potensi untuk menyingkirkan kira-kira 93% kekeruhan akhir air sisa pada optimum pH 3 dan dengan 120 mg / L dos. Seterusnya, prestasi JC sebagai bio-penggental telah dibandingkan dengan penggental aluminium sulfat (tawas). Hasil kajian menunjukkan bahawa tawas memberikan 93% penyingkiran kekeruhan pada pH optimum 5 dan dengan dos optimum 1200mg / L. Rawatan air sisa POME dengan menggunakan hampas JC sebagai bio-penggental telah berjaya mengurangkan COD dengan sehingga 70%, 65% pengurangan BOD dan 88% penyingkiran TSS, manakala penggental tawas menurunkan 59% COD , 61% pengurangan BOD dan 71% penyingkiran TSS.

Objektif kedua kajian ini adalah untuk mengkaji komposisi benih JC dan hampas JC yang dianggap berpotensi sebagai agen penggental untuk pemerawatan air sisa dengan menggunakan analisis Cecair Kromatografi Berprestasi Tinggi (HPLC). Hasil kajian menunjukkan bahawa 18 jenis asid amino telah dikesan. Asid amino jenis lisin telah dikesan mempunyai komposisi tertinggi dalam benih Jatropha curcas dengan 24.87%, diikuti oleh asid amino jenis cystine dengan komposisi sebanyak 21.74%. hampas JC, dari sudut yang lain pula mempunyai komposisi tertinggi bagi asid amino jenis Phenylalanine dengan 15.34%, diikuti oleh asid amino jenis cystine, dengan 14.21%.

Bagi objektif ketiga kajian ini, analisis kuantitatif akhir melalui HPLC telah dijalankan. Air sisa akhir POME yang telah dirawat telah melalui analisis HPLC untuk mengesan kehadiran toksik *Phorbol-ester*. Profil HPLC analisis mendapati bahawa tiada puncak *Phorbol-ester* dikesan dalam larutan air sisa yang dirawat.

Kesimpulannya, kajian ini telah membuktikan bahawa hampas JC mempunyai potensi yang tinggi untuk digunakan sebagai bio-koagulan untuk rawatan air sisa. Anggaran kos untuk rawatan menggunakan benih JC adalah RM 0.035 setiap 1 liter air sisa dirawat. Penggunaan hampas JC sebagai agen penggental juga adalah lebih murah daripada penggental jenis benih JC jika hampas JC boleh diperolehi secara terus daripada proses industri pengeluaran minyak *Jatropha*.

## ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to Associate Professor Dr. Zurina Zainal Abidin for her supervision, constructive criticisms, and her invaluable guidance and encouragement throughout my study and preparation of this thesis.

My sincere thanks are also addressed to my supervisory committee member, Professor Dr. Robiah Yunus, for her advice and encouragement during my study.

To my dearest parents, Mr. Madehi Hj Assan and Mdm Mastiah binti Hj. Akoi, thank you so much for your understanding, support, and endless praying during the period of my study. To my special friends, Shairy Abu Bakar, Fatin Nordalila and Muhammad Fatah Ibrahim, thank you for the support given, and being there always for me.

Last but not least, my sincere thanks go to Encik Joha Muhsidi bin Abdul Wahab, Puan Maslinda binti Abdullah and all the staff in Chemical and Environmental Engineering Department for their invaluable help. This thesis would not have been completed without the support from them.

Above all, Alhamdulillah, be praised to Allah swt, the most beneficent, the most gracious and merciful, who has given me physical and emotional strength as well as comfort to successfully complete my study.

**APPROVAL SHEET 1**

I certify that a Thesis Examination Committee has met on (date) to conduct the final examination of Norhafiza Binti Madehi thesis entitled "*Jatropha curcas* As A Potential Bio-coagulant For Wastewater Treatment" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Master Sciences Biochemical Engineering Degree.

Members of the Thesis Examination Committee were as follows:

**Tinia Idaty Mohd. Ghazi, PhD**
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

**Wan Azlina Wan Abdul Karim Ghani, PhD**
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

**Intan Salwani Ahamad, PhD**
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

**Azlina Harun @ Kamaruddin, PhD**
Faculty of Engineering
Universiti Sains Malaysia
(External Examiner)

---

**ZULKARNAIN ZAINAL, PHD**
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

**Appendix D2**

**Approval Sheet 2**

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

**Zurina Zainal Abidin, PhD**
Associate Professor
Faculty of Engineeering
Universiti Putra Malaysia
(Chairman)

**Robiah Yunus, PhD**
Professor
Faculty of Engineeering
Universiti Putra Malaysia
(Member)

---
**BUJANG BIN KIM HUAT, PhD**
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

---

**NORHAFIZA BINTI MADEHI**

Date: February 2013

## TABLE OF CONTENTS