EFFICIENCY OF NATURAL COAGULANTS FOR TREATMENT OF PUBLIC MARKET WASTEWATER

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DEDICATION

To Mom and Dad,
Thanks for the endless love and support.

To lecturers,
Thanks a lot for the guidance and helping.

To the beloved husband, brothers and sisters,
Thanks for making me happy.

To the friends,
I will always remember you,

Thank you all…

Love,
-RosmawanieRadzuan-

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Finally, I hope this study may be blessed by Him and be beneficial in the future.

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ABSTRACT

The study aimed to investigate the efficiency *Moringa oleifera* seed and Chickpea (*Cicer arietinum*) for the reduction Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), Oil and Grease (O&G), turbidity and colour in public market wastewater. Optimization studies were undertaken for different dosage, pH and mixing rates. The samples of wastewater were collected from Rengit Public Market, Batu Pahat. The efficiency of *M. oleifera* seed and *C. arietinum* were investigated in coagulation and flocculation process with jar test to determine the optimum of dosage, pH and mixing rate. The results revealed that *M. oleifera* and *C. arietinum* exhibited high efficiency for the reduction COD, TSS, O&G, colour and turbidity with 180 mg/L of dosage concentration at pH 7 and 150 rpm of mixing rate. The lab-scale system was designed with 6 liters of capacity and 3 effluent collection tanks at the optimal conditions determined in this study. The adsorption isotherms and equilibrium model of adsorption system were analysis using Langmuir and Freundlich models. The adsorption isotherms studies were fitted well by Langmuir model than Freundlich model. The R_L value was 47.39 mg/L, 9.20 mg/L, 54.64 mg/L, 1.51 *Pt.Co* and 2.91 NTU for COD, TSS, O&G, colour and turbidity respectively, which indicated the favourability of *M. oleifera* as an efficient coagulants. The results proved that *M. oleifera* and *C. arietinum* as natural coagulants have the capability to remove pollutants in wastewater. The study shows that *M. oleifera* seed and *C. arietinum* act as an efficient natural coagulants, flocculant and adsorbent for the treatment of public market wastewater to reduce COD, TSS, O&G, colour and turbidity.

ABSTRAK

Kajian ini bertujuan untuk mengkaji keberkesanan biji *Moringa oleifera* dan kacang kuda (*Cicer arietinum*) bagi mengurangkan Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), Minyak dan Gris (O&G), kekeruhan dan warna dalam air sisa di pasar awam. Kajian pengoptimuman diuji untuk dos yang berbeza, pH dan kadar pencampuran. Sampel air sisa diambil dari Pasar Awam Rengit, Batu Pahat. Kecekapan *M. oleifera* dan *C. arietinum* telah dijalankan pada proses pembekuan dan pemberbukuan dengan ujian balang untuk menentukan optimum dos, pH dan kadar pencampuran. Hasil kajian menunjukkan *M. oleifera* dan *C. arietinum* mempunyai kecekapan yang tinggi untuk pengurangan COD, TSS, O&G, warna dan kekeruhan dengan 180 mg/L kepekatan dos pada pH 7 dan kadar pencampuran 150 rpm. Dalam kajian ini, sistem tangki rawatan telah direka dengan kapasiti 6 liter dan 3 tangki pengumpulan efluen pada keadaan optimum telah dipilih. Isoterma penjerapan dan keseimbangan pemodelan sistem penjerapan telah dikaji dengan menggunakan model Langmuir dan Freundlich. Model Langmuir adalah isoterma penjerapan yang tepat berbanding model Freundlich. Nilai R_L adalah 47.39 mg/L, 9.20 mg/L, 54.64 mg/L, 1.51 *Pt.Co* and 2.91 NTU untuk COD, TSS, O&G, warna dan kekeruhan, yang menunjukkan *M. oleifera* sebagai koagulan yang cekap. Keputusan telah membuktikan bahawa *M. oleifera* dan *C. arietinum* sebagai koagulan semula jadi mempunyai tindak balas dengan air sisa untuk mengurangkan pencemaran dalam air sisa. *M. oleifera* dan *C. arietinum* juga bertindak sebagai koagulan semula jadi, pemberbukuan dan penjerap yang efisien untuk rawatan air sisa pasar awam untuk mengurangkan COD, TSS, O&G, warna dan kekeruhan dengan berkesan.

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LIST OF ABBREVIATION

BOD	Biological Oxygen Demand
Ce	Equilibrium of Concentration
C*i*	Equilibrium of Initial
COD	Chemical Oxygen Demand
EQA	Environmental Quality Act
HCL	Hydrochloric Acid
K_f	Freundlich constants denoting the adsorption capacity
K_L	Langmuir constants denoting the adsorption capacity
mg/L	Miligram Per Liter
mL	Mililiter
MO	*Moringa Oleifera*
n	Emperical constant indicating of adsorption intensity
NaOH	Sodium Hydroxide
NTU	Nephelometric Turbidity Units
O&G	Oil and Grease
Pt.Co	Platinum-Cobalt
qe	Equilibrium sorption capacity
q_{max}	Equilibrium Maximum
R^2	Coefficients of Determination
RPM	Revolutions Per Minute
RPMW	Rengit Public Market wastewater
TSS	Total Suspended Solid
SEM	Scanning Electron Micrograph
UTHM	Universiti Tun Hussein Onn Malaysia

LIST OF PUBLICATION

Rosmawanie MR, Mohamed RMSR, Kassim AH, Using *Moringa Oleifera* Seed and *Cicer arietinum* as Natural Coagulant in Wastewater Treatment, a Review.

Rosmawanie MR, Al-Gheethi AA, Mohamed RMSR, Pahazri NF, Kassim AH, Shaylinda MZ, Sequestering of Pollutants from Public Market Wastewater using *Moringa oleifera* and *Cicer arietinum* Flocculation. *Journal of Environmental Chemical Engineering Science and Pollution Research.*

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

The rapid increase of the population around the world are associated with using huge quantities of water in different industrial and agriculture as well as household activities. The characteristics of the wastewater in terms of chemical and biological residues are different depend on the type of the activities in each sector. The treatment of wastewater before the final disposal or reuse became an urgent need not only to meet the international standards but also in order to protect the next generations and ensure the availability of pure water for their survival. In India as (one of the most developing countries), only 10% of generated wastewater is treated, while 90% of those wastes are disposed to the natural water bodies as raw wastes. These practices reflect the challenges who the next generation face it in order to get a clean water (Rao, 2005). It has been revealed that more than 10,000 new organic compounds are added to the environment via the wastewater discharge every year (Chandra and Kulshrenta, 2004).

One of the major wastewater which really need to be highlight is the public market wastewater derived from poultry, fishes and vegetables sales (Sze-ki, 2008). These wastes are characterized by high level of organic materials, suspended solids, fats, oils and grease. It has been demonstrated that the disposal of these wastes with high amount of nutrients contribute in the occurrence of eutrophication phenomenon and algae bloom in the fresh water (Jais *et al*., 2016). For example, wastewater from Manjuyod public market in Philippines was considered as one of the major source which contributed to the wastewater quality issues (Santos & Robbin, 2007).

The physical and chemical characteristics of wastewaters depend on their source. The industries, hospitals, households, wet market, car wish wastewater have different compositions. Industrial wastewaters contains high suspended, colloidal and dissolved solids, heavy metals are available with high concentrations (Alturkmani, 2007). Hospital wastewaters are rich with pharmaceutical wastes such as antibiotics and infectious agents. In the contrast, the public market wastewater have high organic constitutes. Some of the characteristics are critical to determine the quality of the wastewater such as organic constitutes, while others such as temperature and colour are varied depend on the environmental climate and conditions, for instance wastewater temperature in cold regions ranged from 7 to 18 °C, while range from 13 and 24 °C in their values effect on the wastewater composition due to their role in the chemical and biological reactions. The variations in temperature is associated with the changes in pH, conductivity and saturation level of gases. Therefore, these parameters should also be considered for the assessment the quality of wastewater. The colour parameter is an indicator for the level of total suspended solids and dyes in the wastewater (Dubey, 2013). Indeed the wastewater parameters interacted together and the analysis for each parameters separately does not give a whole idea for the wastewater quality and the expected effects on the environment as well as selection of the treatment technology. Besides, the composition of wastewater are varies seasonally and geographically based on the local activities and total population in the specific area, as well as presence or absence the transport system of the wastewater (Yaakob *et al*., 2011).

1.2 Treatment Technologies of Wastewater

The design and selection of the treatment technologies aimed mainly to reduce the main pollutants in the wastewater before the final disposal into the environment. The level of treatment process required is differ based on location, economic resources, living standards of different countries, characteristics of water and its pollutants (Bustillo & Mehrvar, 2015).

There are many of wastewater treatment technologies which depend on the utilization of chemical substances, or semi synthetic material in the treatment process. Others advanced technologies included up-flow anaerobic sludge blanket (USAB), multi stage bubble column reactor, sequential batch reactor (SBR), fixed film anaerobic filter (AF), expanded granular sludge bed (EGSB), which is a modification to UAS , up-flow septic tank/baffled reactor (USBR), submerged membrane hybrid system, anaerobic-anoxic-aerobic bioreactor. These technologies have advantages and disadvantages in terms of construction costs, operational costs, energy consumption, operational complexity, effluent quality, reliability, land requirements, and environmental impact. In Malaysia, the treatment technologies focus to provide a basic standard of EQA1974, Regulation 2009, (Sewage) Standard A and B (Wan Abdullah, 2011; Azman and Shaari, 2013; IWK, 2016).

The coagulation/flocculation is a one of the process used during the treatment of wastewater after the primary and secondary stage which used for the removal of solid materials. The main objective for the coagulation/flocculation process is to the remove of soluble organic matters. They are efficient for reduction of Biochemical oxygen demand (BOD), Chemical oxygen demand (COD) and suspended solid (SS) as well as turbidity (Muralimohan *et al*., 2014). Hence, in the absence of solid matters in the wastewater such as public market wastewater, the coagulation/flocculation process might be efficient for the improvement of wastewater quality without the need for primary and secondary process.

Coagulants neutralise the repulsive electric charge (negative) surrounding particles allowing them to “stick together” creating flocs. Flocculation facilitate the sticking of the coagulated particles to form larger floccules and their by fasten gravitational settling. Different coagulants included chemical, biological and natural substances. The toxic by-products of chemical coagulants as well as the cost of the biological coagulants production has induced the researchers to find alternative coagulants which has high efficiency, low cost of productivity and eco-friendly. These characteristics are available in the natural coagulants. Therefore, the aims of this study is to evaluate the efficiency of coagulation and flocculation process is to the remove of COD, TSS, O&G, colour and turbidity of public market wastewater treatment.

1.3 Problem Statement

Some of the current technologies used for the treatment of public market wastewater are aerobic and anaerobic sequencing batch reactors (Ruiz *et al*., 1997; Masse and Masse 2000; Rahimi *et al*., 2011). These techniques are effective for the reduction of COD, BOD and TSS of the wastes. Nevertheless, the challenges associated with these technologies are the high cost for operation and maintenance which limit the application these systems for each public market centre. These gaps offer opportunity for the researchers to find alternative technologies with low cost and high efficiency and without secondary effects on the environment. In the few last years, the scientists shifted to use the natural products for the treatment of wastewater. This idea has taken from the fact that the nature have high potential to repair itself if the human stop the discharge a new pollutants to it. Therefore, it is very important for the researchers to discover many great natural resources for water treatment (Muhammad *et al*., 2015). In water treatment process, the utilization of natural coagulants have various advantages in comparison to the chemical agents and other traditional treatment process, particularly in term of biodegradability, non-thermal process, low toxicity and low residual sludge production (Antov *et al*., 2012; Thakur and Choubey 2014).

The coagulation and flocculation process using wide range of natural coagulants have exhibited high efficiency for the removal of pollutants from different wastewater, which indicating their potential as a good alternative treatment technology for the wastewater. The use of natural coagulants such as *Moringa oleifera* seed and *Chickpea (Cicer arietinum)* for public market wastewater treatment has not been investigated before, these emphasize the novelty of the current work.

Many advantages available if this technology were applied, including easy implementable as individual treatment unit for each public market. Also in term of low cost because the availability of raw materials and energy required for the operation in comparison to the traditional treatment system. Other than that, the high efficiency for reduction organic and inorganic pollutants from different wastewater.

1.4 Research Objectives

The main goal for the present study is to investigate the efficiency of coagulation and flocculation process using *Moringa oleifera* seed and Chickpea (*Cicer arietinum*) as an alternative treatment method for public market wastewater. The specific objective are as following:

i) To investigate the efficiency of *Moringa oleifera* seed and Chickpea (*Cicer arietinum*) in the reduction of the main parameters of the wastewater.

ii) To optimise the factor and to determine the effect of different dosages, pH and mixing rates for the application of natural coagulants (*Moringa oleifera* seed and Chickpea (*Cicer arietinum*).

iii) To study the adsorption capacity of *M. oleifera* seed and *C. arietinum* to remove COD, TSS, O&G colour and turbidity from the wastewater along with parameters (adsorption dose, contact time and pH) that effected the adsorption process.

iv) To evaluate the efficiency of the lab-scale coagulation and flocculation public market wastewater treatment system.

1.5 Scope of Research

This study was carried out by coagulation and flocculation as a treatment technology to treat public market wastewater. The sample of wastewater was obtained from Rengit Public Market, Batu Pahat, Malaysia. Parameters tested include Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended were

Solid (TSS), Oil & grease (O&G), colour and turbidity and pH. Coagulation and flocculation process was conducted with Jar Test using natural coagulants, *Moringa oleifera* seed and Chickpea (*Cicer arietinum*) seed powder as a natural adsorbent for special pollutant removal. Lastly, the optimum results of dosage, pH and rapid mixing rates are determined and were applied in real lab-scale treatment system.

1.6 Expected of Research

Public market wastewater contains nutrient and elements derived from fresh foodstuff, waste scraps of poultry, meat cutting and fish entrails. Uncontrolled public market wastewater disposal can aggravate mosquitoes and flies breeding grounds, and produce smelly stagnant waters, in addition to problem to human health. A study was conducted using natural coagulants to treat the public market wastewater. This can normally solved by adding natural coagulants. Through this study, the efficiency of using natural coagulant in wastewater treatment can be determined. From this application, public market wastewater can be treated and the colour of water more be clean than before to discharge to the river. The knowledge will be beneficial to local authority, public market management and future researchers so that they can develop and improve the strategy to overcome public market wastewater problem.

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