GARBAGE ENZYME AS AN ALTERNATIVE METHOD IN TREATMENT OF SULLAGE

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Buat keluarga yang dikasihi, tunang yang diingati & sahabat yang sentiasa disisi..

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ABSTRAK

Kajian ini dijalankan bagi meneroka kebolehlaksanaan menggunakan enzim bahan buangan bagi merawat air basuhan dapur. Enzim disediakan daripada hampas buah-buahan, bahan buangan dapur, gula perang dan air yang mampu mengukuhkan fungsi pembersihan dengan berkesan. Dalam kajian ini, air basuhan dapur diambil di saliran terbuka di Arked Cengal. Arked Meranti dan Kafeteria Kolej 9 dan enzim dibuat di makmal. Air basuhan dapur yang diambil dan dianalisis untuk parameter BOD, COD, TSS dan minyak dan gris. Dari hasil yang diperolehi, semua sampel dirawat oleh enzim bahan buangan menunjukkan penyingkiran BOD ialah 60%, COD dan minyak dan gris hampir 90%, kemudian TSS ialah 80% selepas 7 hari rawatan dengan menggunakan dos enzim berbeza. Arked Meranti, Cengal Arked Dan Kolej 9 Buah Kafeteria Universiti Teknologi Malaysia (UTM) menunjukkan penyingkiran BOD, 85%, COD, 90%, O&G, 63% dan hampir TSS, 100% peratus pengurangan selepas rawatan.

ABSTRACT

This study was conducted to explore the feasibility of using Garbage Enzyme to treat sullage. The enzyme was prepared from fruits dregs, kitchen waste, molasses and water and capable of having reinforcing and cleaning function to work with nature. In this study, sullage was collected at open drainage at Arked Meranti, Arked Cengal and Kolej 9 cafeteria's and enzyme dosage determinations were done at laboratory scale. Sullage collected were analysed for BOD, COD, TSS and oil and grease. From the result obtained all samples treated using garbage enzyme prepared shows removal of BOD was 60% , COD and oil and grease almost 90%, then TSS was 80% after 7 days of treatment with different dosage of enzyme. Treatment from Arked Meranti, Arked Cengal and Kolej 9 Cafeteria in Universiti Teknologi Malaysia (UTM) show removal of BOD was 85%, COD, 90%, O&G 63% and lastly, almost TSS 100% of removals were obtained respectively after the treatment.

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UTM	-	Universiti Teknologi Malaysia
BOD	-	Biochemical Oxygen Demand
COD	-	Chemical Oxygen Demand
TSS	-	Total Suspended Solid
O&G	-	Oil and grease

CHAPTER I

INTRODUCTION

1.1 Introduction

Sullage water is all of the wastewater from plumbing fixtures except the toilet. Usually waste from the kitchen sink is connected to the septic tank as the high levels of fats, organic matter, suspended solids and microorganisms require treatment before discharge into an absorption trench (or other treatment system). Sullage water does contain high levels of microorganisms that make it unsuitable for spray irrigation. Salts and phosphorus from laundry detergents are pollutants. Sodium salts can cause some clay soils to lose structure and become unsuitable for absorption. It is therefore advisable to use laundry detergents with low sodium. Generally, liquids and concentrates have lower sodium than powders. Single purpose septic tanks or lint traps should be installed for treating sullage water. Hair and lint in sullage water can clog up the soil and cause absorption trenches to fail. Sullage water may be re-used in a sub soil irrigation area, providing it is screened and filtered to remove hair, lint and other suspended particles. A special design will be required for the sub-soil distribution system along with details of the pumping system and how hair, lint and suspended matter will be removed (Sorell, 2000). In order to save environment, the only way is to control from the root cause. So, it is ease to manage the environmental if the preventing starting from the beginning of waste production.

1.2 Problem of Statement

Restaurants and food centers produce a lot of wastewater rich in oil and grease content which is present in the drain lines. It often congeals within drain and sewer lines and cause blockages. Grease traps may also fail to retain dissolved and emulsified the oil and grease efficiently. If oil and grease is not properly treated by the whole wastewater treatment process, it may enter rivers and oceans with potentially harmful environment impacts.

Major problems that wish to be studied are due to the quality of the sullage at Arked Meranti, Arked Cengal, Kolej 9 Cafeteria Universiti Teknologi Malaysia (UTM)

1.3 Aim of the Study

The purpose of this study is to test out the Garbage Enzyme as an alternative method to treat the sullage. Besides that also, this study will also investigates the effectiveness of garbage enzyme.

1.4 Objectives of the Study

The objectives of this study are:

1. To prepare garbage enzyme from fruits dregs and kitchen waste for sullage treatment.
2. To determine the current sullage conditions of Arked Meranti, Arked Cengal and Kolej 9 Cafeteria.
3. To investigate the effectiveness of using garbage enzyme as an alternative media in sullage treatment.

1.5 Scope of the Study

The scope of the study is:

1. To prepare the enzyme using fruits dregs which is Quinine fruits dreg and kitchen waste.

2. The sullage will be collected is from Arked Meranti, Arked Cengal and Kolej 9 Cafeteria in UTM.

3. The parameter will be analysed are BOD, COD, TSS and oil & grease.

CHAPTER 2

LITRETURE REVIEW

2.1 Water pollution

Water pollution is a major problem in the global context. It has been suggested that it is the leading worldwide cause of deaths and diseases (Pink, 2006) (West, 2006) and that it accounts for the deaths of more than 14,000 people daily. (West, 2006) In addition to the acute problems of water pollution in developing countries, industrialized countries continue to struggle with pollution problems as well. In the most recent national report on water quality in the United States, 45 percent of assessed stream miles, 47 percent of assessed lake acres, and 32 percent of assessed bay and estuarine square miles were classified as polluted (EPA, 2002)

Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support a human use, like serving as drinking water, and/or undergoes a marked shift in its ability to support its constituent biotic communities, such as fish. Natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water. Water pollution has many causes and characteristics.

The major pollutants were Biochemical Oxygen Demand (BOD), Ammoniacal Nitrogen (NH3-N) and Suspended Solids (SS). In 2006, 22 river basins were categorized as being polluted by BOD, 41 river basins by NH3-N and 42 river basins by SS. High BOD was contributed largely by untreated or partially treated sewage and discharges from agro-based and manufacturing industries. The main sources of NH3-N were domestic sewage and livestock farming, whilst the sources for SS were mostly earthworks and land clearing activities (Department of Environment, 2006). Continuous monitoring is vital for early detection of pollution influx. Over the years, a number of pollution incidences had been observed at several continuous monitoring stations. For the period of January to December 2006, 21 incidences of distinctive pollution influx were observed (Table 2.1).

Table 2. 1: Malaysia: Pollution Influx Observed at Continous Water Quality Station

Station	Date	Parameter	Pollution Sources
Sungai Batang Benar	14 Jan `06	NH_4 : 3.36 mg/l Turbidity : 23.55 NTU	Sewage or latex based industry

Sungai Linggi	23 Jan `06	NH_4 : 3.79 mg/l Turbidity : 242 NTU	Sewage or earthworks
Sungai Batang Benar	25 Jan `06	NH_4 : 2.16 mg/l Turbidity : 122.26 NTU	Sewage or latex based industry and industrial discharge
Sungai Melaka	15 Feb `06	NH_4 : 3.37 mg/l pH : 6.50	Sewage or latex based industry
Sungai Skudai	22 Feb `06	NH_4 : 7.86 mg/l Turbidity : 714.87 NTU	Sewage or latex based industry
Sungai Selangor	26 Feb `06	NH_4 : 4.51 mg/l pH : 6.05 NTU	Sewage or latex based industry
Sungai Batang Benar	29 Mar `06	NH_4 : 2.80 mg/l Conductivity : 214.25μS/cm	Sewage or latex based industry
Sungai Batang Benar	11 Apr `06	NH_4 : 3.09 mg/l DO : 1.55 mg/l	Sewage or latex based industry
Sungai Batang Benar	12 Apr `06	NH_4 : 2.48 mg/l DO : 2.82 mg/l	Sewage or latex based industry
Sungai Langat	15 Apr `06	NH_4 : 7.51 mg/l DO : 0.28 mg/l	Sewage or latex based industry
Sungai Batang Benar	15 Apr `06	NH_4 : 2.05 mg/l DO : 3.45 mg/l	Sewage or latex based industry
Sungai Batang Benar	23 Apr `06	NH_4 : 3.53 mg/l Turbidity : 863 NTU	Sewage or latex based industry
Sungai Labu	25 Apr `06	NH_4 : 2.89 mg/l DO : 0.26 mg/l	Sewage or latex based industry
Sungai Batang Benar	2 May `06	NH_4 : 5.25 mg/l	Sewage or latex based industry
Sungai Batang Benar	29 May `06	NH_4 : 3.23 mg/l DO : 0.67 mg/l	Sewage or latex based industry
Sungai Batang Benar	13 Jun `06	NH_4 : 4.05 mg/l	Sewage or industrial discharge

		Conductivity : 339 μS/cm	
Sungai Labu	11 Jul `06	NH_4 : 5.07 mg/l	Sewage or industrial discharge
Sungai Batang Benar	4 Aug `06	NH_4 : 4.85 mg/l	Sewage or industrial discharge
Sungai Batang Benar	31 Aug `06	NH_4 : 4.02 mg/l	Sewage or latex based industry
Sungai Keratong	21 Oct `06	NH_4 : 5.95 mg/l	Sewage or industrial discharge
Sungai Batang Benar	10 Nov `06	NH_4 : 4.14 mg/l Conductivity : 242 μS/cm	Sewage or industrial discharge

2.2 Sources of water pollution

Water pollution is caused by point and non-point sources. Point sources include sewage treatment plants, manufacturing and agro-based industries and animal farms. The Non-point sources are defined as diffused sources such as agricultural activities and surface runoffs.

In 2006, the Department of Environment (DOE) registered 18,956 water pollution point sources comprising mainly sewage treatment plants (9,060 : 47.79% inclusive of 601 Network Pump Stations), manufacturing industries (8,543 : 45.07%), animal farms (869 : 4.58%) and agro-based industries (484 : 2.55%) represents the distribution of industrial water pollution sources from agro-based and manufacturing industries compiled by the DOE in 2006 through field surveys and questionnaires. A total of 9,027 sources were identified with Selangor having the highest number of water pollution sources (1,850 : 20.49%), followed by Johor (1,774 : 19.65%).

According to statistics compiled by the Veterinary Department of Malaysia, the total standing pig population for 2006 was about 1.67 million, a decrease of 1.76 percent compared to 1.7 million in 2005. Correspondingly, the number of pig farms decreased to 869 farms compared to 898 in the previous year.

The number of sewage treatment plants under the management of Indah Water Konsortium Sdn. Bhd. (IWK) had increased to 9,060 in 2006 compared to 8,782 plants in 2005. Selangor had the largest number of sewage treatment plants (2,563 : 28.3%), Perak (1,343 : 14.8%), Johor (1,010 : 11.1%) and Negeri Sembilan (928 : 10.2%) .

2.2.1 Point source pollution

Point source pollution refers to contaminants that enter a waterway through a discrete conveyance, such as a pipe or ditch. Examples of sources in this category include discharges from a sewage treatment plant, a factory, or a city storm drain.

Point source pollution of our nation's river, lakes, and coastal waters has been greatly reduced over the past three decades. The Clean Water Act passed by the U. S. Congress in 1972 and amended in 1977, seeks to eliminate the discharge of any pollutant from a point source into any U.S. water body. It has made the dumping of untreated wastewater from a point source illegal and set penalty for violations. A lot of progress in reducing point source pollution has been made in the United States and we need to continue to improve upon past success. This success; however, is at best only a partial one. In order to continue making progress in water quality, non-point sources pollution should be focus of.

2.2.2 Non-point source pollution

Non-point source (NPS) pollution refers to diffuse contamination that does not originate from a single discrete source. NPS pollution is often accumulative effect of small amounts of contaminants gathered from a large area. The leaching out of nitrogen compounds from agricultural land which has been fertilized is a typical example. Nutrient runoff in stormwater from "sheet flow" over an agricultural field or a forest is also cited as examples of NPS pollution.

Contaminated storm water washed off of parking lots, roads and highways, called urban runoff, is sometimes included under the category of NPS pollution. However, this runoff is typically channelled into storm drain systems and discharged through pipes to local surface waters, and is a point source. However where such water is not channelled and drains directly to ground it is a non point source.

2.2.3 Sullage

Wastewater is comprises of liquid waste discharged by domestic residences, commercial properties, industry, and an agriculture and can encompass a wide range of potential contaminants and concentrations. In the most common usage, it refers to the municipal wastewater that contains a broad spectrum of contaminants resulting from the mixing of wastewaters from different sources. Many waste water discharges into river and pond are through open-ended pipes that achieve minimal initial mixing. The open-ended dischages on the bank sometimes free-fall into water surface, with the potential for foaming problems (Howard, 1985) .

Sullage water is all of the wastewater from plumbing fixtures except the toilet. Usually waste from the kitchen sink is connected to the septic tank as the high levels of fats, organic matter, suspended solids and microorganisms require treatment before discharge into an absorption trench (or other treatment system). Sullage water does contain high levels of microorganisms that make it unsuitable for spray irrigation. Salts and phosphorus from laundry detergents are pollutants. Sodium salts can cause some clay soils to lose structure and become unsuitable for absorption. It is therefore advisable to use laundry detergents with low sodium. Generally, liquids and concentrates have lower sodium than powders. Single purpose septic tanks or lint traps should be installed for treating sullage water. Hair and lint in sullage water can clog up the soil and cause absorption trenches to fail. Sullage water may be re-used in a sub soil irrigation area, providing it is screened and filtered to remove hair, lint and other suspended particles. A special design will be required for the sub-soil distribution system along with details of the pumping system and how hair, lint and suspended matter will be removed (Sorell, 2000).In order to save environment, the only way is to control from the root cause. So, it is ease to manage the environmental if the preventing starting from the beginning of waste production.

2.2.2.1 Characteristics of sullage

The characteristics of grey wastewater depend firstly on the quality of the water supply, secondly on the type of distribution net for both drinking water and the grey wastewater (leaching from piping, chemical and biological processes in the biofilm on the piping walls) and thirdly from the activities in the household. The compounds present in the water vary from source to source, where the lifestyles, customs, installations and use of chemical household products will be of importance. The composition will vary significantly in terms of both place and time due to the variations in water consumption in relation to the discharged amounts of substances. Furthermore, there could be chemical and biological degradation of the chemical compounds, within the transportation network and during storage (Eriksson, 2002).

2.2.2.2 Physical and chemical parameters

Physical parameters of relevance are temperature, colour, turbidity and content of suspended solids. High temperatures may be unfavourable since they favour microbial growth and could in supersaturated waters, induce precipitation (e.g. calcite). Food particles and raw animal fluids from kitchen sinks and soil particles, hair and fibres from laundry wastewater are examples of sources of solid material in the grey wastewater.

Measurements of turbidity and suspended solids give some information about the content of particles and colloids that could induce clogging of installations such as the piping used for transportation or sandfilters used for treatment. Although the amount of solids is expected to be lower than in combined wastewater, the risk for practical problems related to clogging should not be neglected. The reason is that the combination of colloids and surfactants (from detergents) could cause stabilisation of the solid phase, due to sorption of the surfactants on the colloid surfaces. This prevention of agglomeration of the colloidal matter will reduce the efficiency of a pre-treatment step including settling of solid matter. The effects from infiltrating grey wastewater on soil

pH and buffering capacity will be determined by the alkalinity, hardness and pH of the infiltrating water.

However, the effect observed will also be influenced by the natural buffering capacity of the soil. The properties of the soil, regarding the sorption capacity of pollutants, will change as a result of the infiltration. In addition, measurements of alkalinity and hardness will, in a way similar to turbidity and content of suspended solids, give some information concerning the risk of clogging. These parameters are largely determined by the quality of the drinking water, while the influence of chemicals added during the use of the water is generally limited in relation to these parameters. Measurements of the traditional wastewater parameters like BOD, COD and the concentration of nutrients (N and P) will also give valuable information.

The content of BOD and COD will indicate the risk of oxygen depletion due to degradation of organic matter during transport and storing and thereby the risk for sulphide production. Among the other pollutants, the content of heavy metals (e.g. Al, Fe, Mn, Cd, Cu, Pb, Hg, Zn, Ni, Cr) and xenobiotic organic compounds XOCs will be of importance. One other important factor to take into consideration is what happens during storage of grey wastewater; the characteristics of the fresh grey wastewater and that stored can differ substantially.

Eriksson, 2002 have looked at the impact storage has on grey wastewater. It found that storage for 24 hours improved the quality of the water but storage for more than 48 hours could be a serious problem as the dissolved oxygen was depleted.

From previous Eriksson 2002 had found the measurement for COD 8000 mg/l, BOD more than 1460mg/l. It depends the sources of the discharge such as the bathroom fraction contains 184–633 mg/l COD and 76–300 mg/l BOD; the laundry fraction contains 725–1815, respectively 48–472 mg/l; the kitchen fraction 26–1380, respectively 5–1460 mg/l whereas the mixed grey wastewater range was between 13-ca. 8000 and 90–360 mg/l. The corresponding levels in household wastewater are COD 210–740 and BOD 150–530 mg/l. Most of the COD derives from household chemicals like dishwashing and laundry detergent, so COD is expected to be at the same levels as the COD in household wastewater. These findings illustrate that the different types of grey wastewater could be suitable for different types of reuse, and there will be different needs for pre-treatment depending on both the types of grey wastewater and the intended use of the water.

2.3 Water Quality Parameters

Water quality is another aspect to be considered of in any assessment of quality in any water body. The water quality parameters that will affect water body such as BOD, COD, TSS, oil and grease.

2.3.1 Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand or BOD is a chemical procedure for determining the rate of uptake of dissolved oxygen by the rate biological organisms in a body of water use up oxygen. It is not a precise quantitative test, although it is widely used as an indication of the quality of water.

2.3.2 Chemical oxygen demand (COD)

In environmental chemistry, the chemical oxygen demand (COD) test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water (e.g. lakes and rivers), making COD a useful measure of water quality. It is expressed in milligrams per litre (mg/L), which indicates the mass of oxygen consumed per litre of solution. Older references may express the units as parts per million (ppm).

2.3.3 Total suspended solid (TSS)

Solids suspended in water may consist of inorganic and organic particles or of immiscible liquids. Inorganic solids such as clay, silt, and other soil constituents are common in surface water. Organic material such as plant fibers and biological solids (algal cells, bacteria, etc.) are also common constituents of surface waters. These materials are often natural contaminants resulting from the erosive action of water flowing over surfaces. Because of the filtering capacity of the soil, suspended material is seldom a constituent of groundwater.

Other suspended material may result from human use of the water. Domestic wastewater usually contains large quantities of suspended solids that are mostly organic in nature. Industrial wastewater may result in a wide variety of suspended impurities of either organic or inorganic nature. Immiscible liquids such as oils and greases are often constituents of wastewater.

Suspended solids, where such material is likely to be organic and/or biological in nature, are an important parameter of wastewater. The suspended solids parameter is used to measure the quality of wastewater influent, to monitor several treatment processes, and to measure the quality of the effluent. Environmental Protection Agency (EPA) has set a maximum suspended solids standard of 30 mg/L for most treated wastewater discharges. (Howard, 1985)

2.3.4 Oil and Grease (O&G)

A variety of organic substance including hydrocarbons, fats, oils, waxes, and high-molecular-weight fatty acids are collectively referred to as oil and grease. (Mark J. Hammer, 2008) The important to determine it is their difficulty in handling and treatment. Since the solubility is low, grease will separated from water and adheres to the interior of pipes and tank walls.

The EPA method for monitoring wastewater discharge under the National Pollutant Discharge Elimination System for oil and grease uses n-hexane as the extraction solvent and gravimetry to determine the quantity of material extracted.

2.4 Enzyme treatment

Enzymes exhibit a number of features that make their use advantageous as compared to conventional chemical catalysts. The enzymes practically do not present disposal problems since, being mostly proteins and peptides; they are biodegradable and easily removed from contaminated streams. This unique set of advantageous features of enzymes as catalysts has been exploited since the 1960s and several enzyme-catalyzed processes have been successfully introduced to industry, e.g. in the production of certain foodstuffs, pharmaceuticals and agrochemicals, but now also increasingly to organic chemical synthesis (Krajewska, 2004).

In understanding enzyme by Palmer, 1985, enzymes are biological catalysts. Biocatalysis is the use of natural catalysts, such as protein enzymes, to perform chemical transformations on organic compounds. Both enzymes that have been more or less isolated and enzymes still residing inside living cells are employed for this task. (Anthonsen, 1999) The rate of chemical reactions is increase to take over the living cells without any changes of themselves. Besides that, all enzymes are proteins. However without the presence of a non-protein component called cofactor, many enzyme proteins lack catalytic activity. When this is the case, the inactive component of an enzyme is termed the apoenzyme, and the active enzyme, including cofactor, the holoenzyme. The cofactor may be an organic molecule, when it is known as a coenzyme, or it may be metal ion. Some enzymes bind cofactors more tightly than others. When a cofactor is bound so tightly that it is difficult to remove without damaging the enzyme it is sometimes called a prosthetic group.

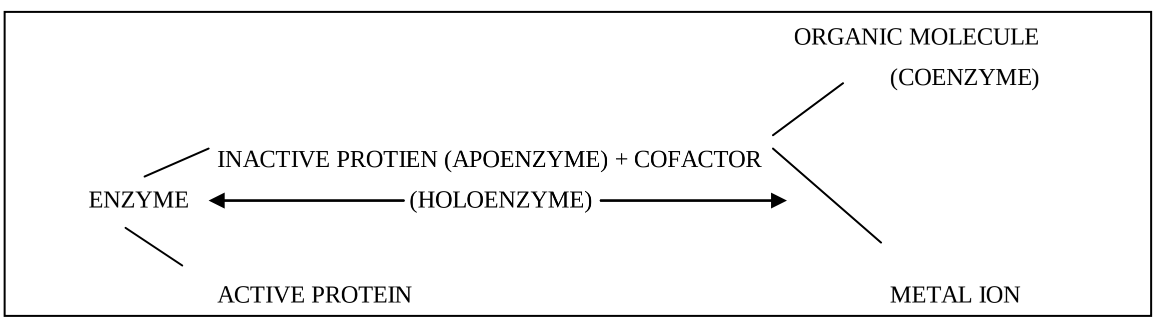

Figure 2. 1 : Summarise diagramatically

2.4.1 Shimanto-gawa method

The Shimanto River, which is famous for its high water quality, runs through the central part of a town. As the Shimanto River is utilized as water source, recreational area and as a sightseeing destination, it is considered a common property of local residents. In 1991, the Shimanto River basin was designated as focus area for tackling domestic wastewater. A Town built this facility in 1996 as one of the Ministry of Environment (MOE) projects for improving domestic wastewater purification. Shimanto-gawa method is models a purification function of the rice paddy. In this process, natural materials such as charcoal, dry vegetation and gravel are utilized for contact media in combination. No chemicals are used. It enables removal of nitrogen and phosphorus with low cost, in addition to BOD, COD, SS and LAS (Linear Alkylbenzene Sulfonate) (WEPA, 1996). The system uses only natural materials and no synthetic chemical for wastewater treatment. With desire to develop low-cost performance equipment to reduce concentrations of nutrients salts, as well as BOD, COD, SS, heavy metals and synthetic detergents, development work began on equipment that used natural materials (Robinson, 2008)

2.4.2 Chitosan

Chitosan is also another method usage for treatment of water and wastewater. The chitosan is biopolymer with significant potential for use as biosorbent for removal of metal ions from wastewater. Dynamics and static adsorption experiments with mercury, chromium and copper ion indicated that chitosan can be effectively used to adsorb these metals. Chitosan, prepared from deacetylation of chitin, which is the major component of crustacean shells and one of the most abundant biopolymer in nature, has been widely investigated for adsorption of heavy metal ions. Its chelating properties are attributed to amino and hydroxyl groups present in chitson chain that can act as chelating sites for several metal ions. In Asian countries such as Thailand, Japan, China, fishery wastes such as shrimp, lobster, and crab shells have been developed into one of the promising options to produce chitosan. These wastes could be obtained for free from local fishery industries. Since such wastes are abundantly available, chitosan may be produced at low cost. (Vieira, 2008)

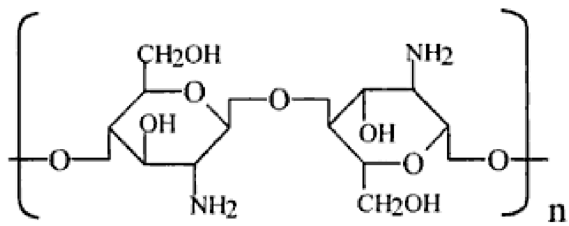

Figure 2. 2: Molecular Structure of Chitosan

2.4.3 Effective Microorganism (EM)

Another method use is Effective Microorganisms, known as EM Technology, is a trademarked term now commonly used to describe a proprietary blend of 3 or more types of predominantly anaerobic organisms that was originally marketed as EM-1 Microbial Inoculant but is now marketed by a plethora of companies under various names, each with their own proprietary blend. "EM

Technology" uses a laboratory cultured mixture of microorganisms consisting mainly of lactic acid bacteria, purple bacteria, and yeast which co-exist for the benefit of whichever environment they are introduced, as has been claimed by the various EM-like culture purveyors. It is reported (Szymanski & Patterson, 2003) to include the Lactic acid bacteria: Lactobacillus plantarum; L. casei; Streptococcus Lactis, Photosynthetic bacteria: Rhodopseudomonas palustris; Rhodobacter sphaeroides, Yeast: Saccharomyces cerevisiae; Candida utilis (no longer used) (usually known as Torula, Pichia Jadinii), Actinomycetes (no longer used in the formulas): Streptomyces albus; S. griseus, Fermenting fungi (no longer used in the formulas): Aspergillus oryzae; Mucor hiemalis.

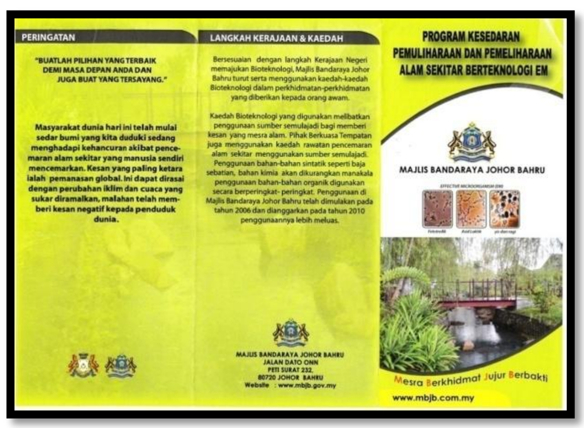

Figure 2. 3: Brochure using EM in Malaysia-Johor

2.4.4 Garbage enzyme

The Garbage Enzyme was invented by Dr Rosukon's. It is a complex organic substance of protein chains and mineral salts and juvenile hormones. The functions of Garbage Enzyme is to resolve (decompose), transform (change), compose (combine) the catalysis. The enzyme converts ammonia to nitrate ($NO3^-$), a natural and useful hormone and nutrient for plants (Ways to Save Energy, 2008).

Because of its unusual properties, molasses has several uses beyond that of a straightforward food additive. It can be used as the base material for fermentation into rum and as the carbon source for in situ remediation of chlorinated hydrocarbons. It can be used as a chelating agent to remove rust where a rusted part stays a few weeks in a mixture of 1 part molasses and 10 parts water. (Anthonsen, 1999)

2.4.4.1 Function of fermentation

Fermentation is the process of deriving energy from the oxidation of organic compounds, such as carbohydrates, and using an endogenous electron acceptor, which is usually an organic compound, (Klein, Prescott, & Harley, 2005) as opposed to respiration where electrons are donated to an exogenous electron acceptor, such as oxygen, via an electron transport chain. Fermentation does not necessarily have to be carried out in an anaerobic environment. For example, even in the presence of abundant oxygen, yeast cells greatly prefer fermentation to oxidative phosphorylation, as long as sugars are readily available for consumption. (Dickinson, 1999)

Molasses are the most common substrate of fermentation, and typical examples of fermentation products are ethanol, lactic acid, and hydrogen. However, more exotic compounds can be produced by fermentation, such as butyric acid and acetone. Yeast carries out fermentation in the production of ethanol in beers, wines and other alcoholic drinks, along with the production of large quantities of carbon dioxide. Fermentation occurs in mammalian muscle during periods of intense exercise where oxygen supply becomes limited, resulting in the creation of lactic acid. (Voet, 1995)

2.4.4.2 Anaerobic respiration

Anaerobic respiration or fermentation entails the generation of energy via the process of oxidation in the absence of oxygen as an electron acceptor. In most eukaryotes, glucose is used as both an energy store and an electron donor. The equation for the oxidation of glucose to lactic acid is:

$$C_6H_{12}O_6 \longrightarrow 2CH_3CH(OH)COOH + 2\ ATP$$

In prokaryotes, multiple electron acceptors can be used in anaerobic respiration. These include nitrate, sulfate or carbon dioxide. These processes lead to the ecologically-important processes of denitrification, sulfate reduction and acetogenesis, respectively. (Zumft, 1997)

The digestion process begins with bacterial hydrolysis of the input materials in order to break down insoluble organic polymers such as carbohydrates and make them available for other bacteria. Acidogenic bacteria then convert the sugars and amino acids into carbon dioxide, hydrogen, ammonia, and organic acids. Acetogenic bacteria then convert these resulting organic acids into acetic acid, along with additional ammonia, hydrogen, and carbon dioxide. Finally, methanogens convert these products to methane and carbon dioxide. (British School, 2003)

CHAPTER 3

METHODOLOGY

3.1 Introduction

The purpose of this study is to use enzyme in treatment of wastewater with high oil and grease content. Therefore, procedures of preparation of fruit enzyme and laboratory test have to be planned and conducted throughout the whole study. This study starts with preparation of fruit enzyme which takes three months to be ready. Next, water samples are collect from sites for laboratory testing and water quality classification. The result of study is obtained from laboratory testing of samples after treatment by enzyme.

3.2 Preparation of fruit enzyme from citrus fruit

In order to prepare citrus fruit enzyme, the ingredients needed are sugar, citrus fruit dregs and water following the ratio of 1: 3:10. An air-tight plastic container is used instead of glass or metal containers that cannot expand. The sugar was diluted in water in a plastic container and followed by adding citrus fruit dregs into it. Some space in the container is keep for fermentation purpose. Then the lid was closed tightly (Ways to Save Energy, 2008).

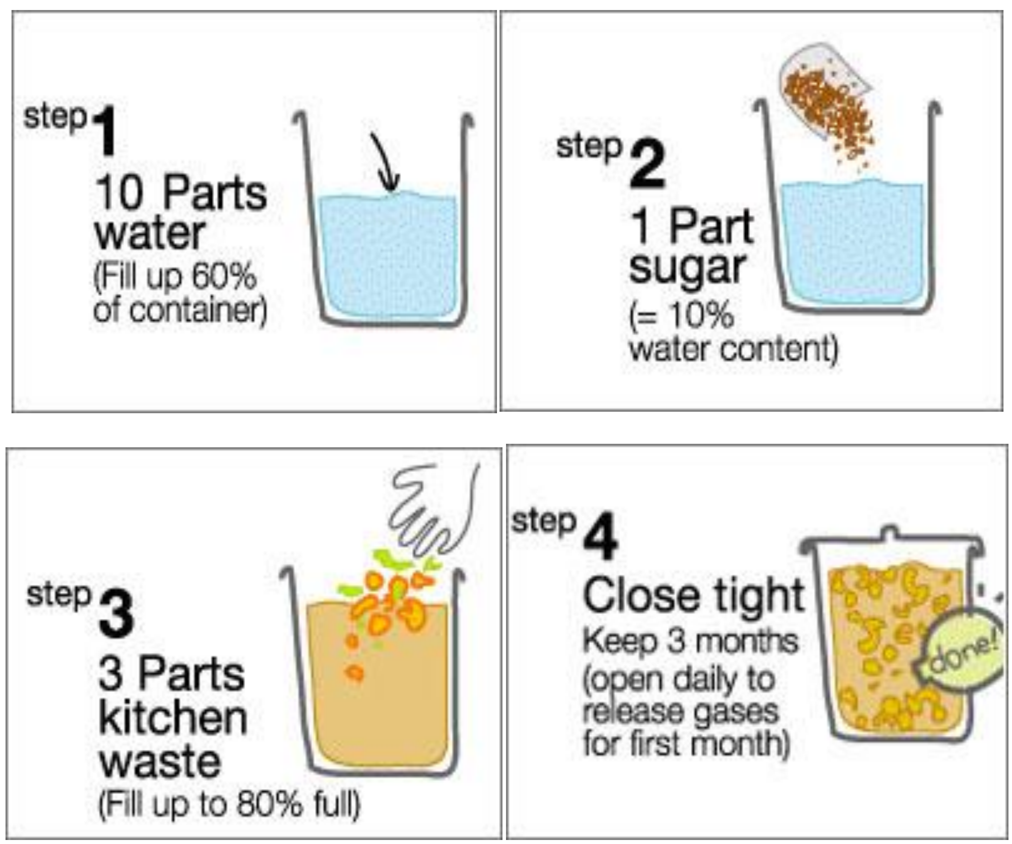

Figure 3. 1: Prepartion of Garbage Enzyme

During the first month, gases will be released during fermentation process. Pressure built up in the container was released daily to avoid rupturing. Fruit dregs are pushed downward every once in a while.

During the first month, gases will be released daily during fermentation process to avoid pressure built up in the container and avoid rupturing. Fruit dregs are pushed downward every once in a while. Lastly, the container is place in the Environment Engineering Laboratory, Faculty of Civil Engineering, UTM at an area which is cool, dry and well ventilated. It has to be left to ferment for at least 3 months before being used.

3.3 Sample Collection

Sampling point of wastewater must be first determined before picking up the water sample. Sullage were collected from end of an open drain every location Arked Meranti, Arked Cengal and Kolej 9 Cafeteria, Universiti Teknologi Malaysia, Johor. The samples were collected in the morning around 10 a.m. because the caterer will operate their premises to provide the food from breakfast and lunch. Most of this time many customers will having their breakfast and lunch especially UTM's staff and students.

3.3.1 Grab sample

Single samples collected at a specific spot (‘snapshot’) and piping a bottle at the water surface. Subsurface grab samplers for accurate remote sampling of streams, rivers, lagoons, manholes and hard to reach areas. Since the sampling point is in drainage system, there will be a grab sample using a proper tool to collect.

Figure 3. 2 Grab sampling

3.3.2 Sample Preservation

To complete preservation of samples is a practical impossibility. The preservation techniques can only retard the chemical and biological changes that inevitably continue after the sample is removed from the parent source. The changes that take place in a sample are either chemical or biological.

3.3.2.1 Chemical Changes

The certain changes occur in the chemical structure of the constituents due to physical conditions. The metal cation may precipitate as hydroxides or form complexes with other constituents.

Cations or anions may change valence states under certain reducing or oxidizing conditions. Other constituents may dissolve or volatilize with the passage of time Metal cation may also adsorb onto surfaces (glass, plastic, quartz, etc.), such as, iron and lead.

3.3.2.2 Biological Changes

Biological changes may change the valence of an element or a radical. The soluboule constituents may be converted to organically bound materials in cell structures, or cell lysis may result in release of cellular material into solution.

The well known nitrogen and phosphorus cycles are examples of biological influence on sample composition.

3.4 Methods of Preservation

Always fill sample containers to the brim and stopper them so that no air is left above the sample. Use an appropriate container. For example, polyethylene bottles should not be used for hydrocarbons, since adsorption on to the bottle's surface is likely to occur.

Glass containers are suitable for most determinations. Brown bottles should be used since this will reduce photosensitive reactions to a considerable extent. Containers must be clean. Whilst this may seem obvious, scrupulous cleanliness is important due to the low detection levels now being adopted. Samples should be kept at a temperature below that at the time of filling.

Cooling between 2 degrees and 5 degrees (ie. in melting ice, refrigerator or cool bag with ice packs) is adequate. It is not suitable for long-term storage. Suspended matter, sediment, algae and other micro-organisms should be removed at the time of sampling by filtration or centrifuging or immediately on receipt at the laboratory. Filtration should not be carried out if the filter is likely to retain one or more of the constituents to be analysed. Generally filtration is achieved by use of 0.45 micron filter paper.

Table 3. 1 The sample container and preservatives for a variety of parameters.

Determination	Sample Container	Preservative	Filtration Required?
BOD	Plastic or Glass	None	No
Carbon, Total Organic	Plastic or Glass	HCl to pH <2	No
Carbon Dioxide	Plastic or Glass	None	No
COD	Plastic or Glass	H_2SO_4 to pH <2	Yes
Conductivity, pH	Glass	None	No
Dissolved Solids	Glass	None	Yes
Odour	Glass	None	No
Oil and Grease	Glass	H_2SO_4 to pH <2	No
Organo Phosphorus	Glass	None	No

3.5 Experimental procedures

Laboratory test was conducted to observe the water quality parameters and classify the water quality condition. Both raw wastewater and treated wastewater will be analysed for BOD, COD, TSS and oil and grease. Comparison will be made between the raw wastewater, treated wastewater and (DOE, 2009)

3.5.1 Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand (BOD) is a parameter which was analysed using HACH method. The volume sample for this test was determined based on BOD range in the HACH manual. The right volume was poured into the BOD bottle and magnetic stirrer was placed in it. Next, BOD Nutrient Buffer Pillow was added into bottle for the optimum bacteria growth. Stopcock grease was applied to seal lip and then the bottle was closed. After that, Lithium Hyrdroxide Powder Pillow was added into the seal cup. Then, the bottle was placed in a BOD track. The bottle was connected to the tube with cap. All the steps for the BOD track setting was followed in the manual. The temperature was adjusted around 20°C for incubator.

Figure 3.3: BOD Track

3.5.2 Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) also analysed using HACH method. The test was needed a reagent which are combination of sulphuric acid, potassium dichromate and distilled water. Also need additional chemicals powder which are argentum sulphate and mercuric sulphate. After that, 3 mL of the reagent was placed into vial. Next, 2mL of the sample and the additional chemical powders were added into vial. For the blank, 2mL of the sample was replaced with distilled water, then, the vials were refluxed for 2 hours. Finally, after the vials were cooled in room temperature, the samples were analysed using HACH DR 5000 Spectrophotometer to get the content of COD in the samples.

Figure 3.4: HACH DR 5000 Spectrophotometer

3.5.3 Total Suspended Solid (TSS)

Dry the filter disk in the oven at 103°C to 105°C for 1 hour, cool in a desiccator and weigh. Assemble filtering apparatus and filter and begin suction. Wet filter with a small volume of distilled water to seat it. Pipette 10 mL of water sample (mixed to ensure homogeneity) onto centre of filter disk in a buchner flask, using gentle suction (under vacuum). Wash filter with three successive 10 mL volumes of distilled water, allowing complete drainage between washings, and continue suction for about 3 min after filtration is complete.

Carefully remove filter from filtration apparatus and transfer to aluminum weighing dish as a support. Dry at least 1 hour at 103°C to 105°C in an oven, cool in a desiccator to balance temperature, and weigh. Repeat the cycle of drying, cooling, desiccating, and weighing until a constant weight is obtained. Duplicate the test for each sample.

Figure 3.5: Apparatus to determine Total suspended solids

3.5.4 Oil and Grease

Dissolved or emulsified oil and grease is extracted from water by intimate contact with an extracting solvent. Some extractables, especially unsaturated fats and fatty acids, oxidize readily; hence, special precautions regarding temperature and solvent vapor displacement are included to minimize this effect. Organic solvents shaken with some samples may form an emulsion that is very difficult to break. This method includes a means for handling such emulsions. Recovery of solvents is discussed. Solvent recovery can reduce both vapor emissions to the atmosphere and costs.

The method used is based on Standard Methods APHA 5520-B to determine the oil and grease content in the sample.

Figure 3.6: Oil and Grease Apparatus

3.5.5 Environmental Quality (Industrial Effluent) Regulations 2009

This regulation is under the Environment Quality Act 1974 Standard A and Standard B is provided in the Fifth Schedule, Environmental Quality (Industrial Effluent) Regulations 2009. This is a sets standard for wastewater discharged from wastewater treatment plant and industrial effluent. Effluent discharged must comply with the parameters limits as stated in standards A and B.

Table 3.2 : Parameter Limits of Effluent of Standards A and B (Environmental Quality (Industrial Effluent) Regulations 2009

Parameter	unit	Standard A	Standard B
Temperature	°C	40	40
BOD_5 at 20˚C	mg/l	20	50
COD	mg/l	50	100
Suspended Solids	mg/l	50	100
Oil and Grease	mg/l	Not Detectable	10.0

3.6 Data Analysis

Data obtained are evaluated in terms of their removal percentage. It also distinguishes the result by varying concentration of enzyme dosage in the treatment test. In order to determine the most effective dosage to treat sullage three type of dilution was carried out. It was prepared at 10, 50 and 100 times of enzyme dilution with addition of sullage. (Szymanski & Patterson, 2003)

A seven days observation had been conducted to see the most effective type of dosage that could remove the pollutant by analysis of BOD, COD, oil and grease and TSS. The treatment will primarily involve oxidation process with a retention time of 24 hours. 5 litres of sullage were collected once a week and analysed for BOD, COD, oil and grease and TSS (Bakar, 2009).

CHAPTER 4

RESULT & DISCUSSION

4.1 Introduction

From the case study the below data were collected for further analysis in order to achieve the objective of this study which is to reduce the pollutant and meet the standard. In order to get a best result, the determinations of dosage were done at preliminaries study. To obtain the high efficiency of the garbage enzyme, there are three concentrations were prepared. There are 10, 50 and 100 times dilution to determine the effectiveness of using garbage enzyme as an alternative media in sullage treatment.

4.2 Current condition of Sullage

Before the treatment applied to the samples, determine the current condition parameters of sullage were conducted. The result will perform in bar graph as to compare between the cafeterias.

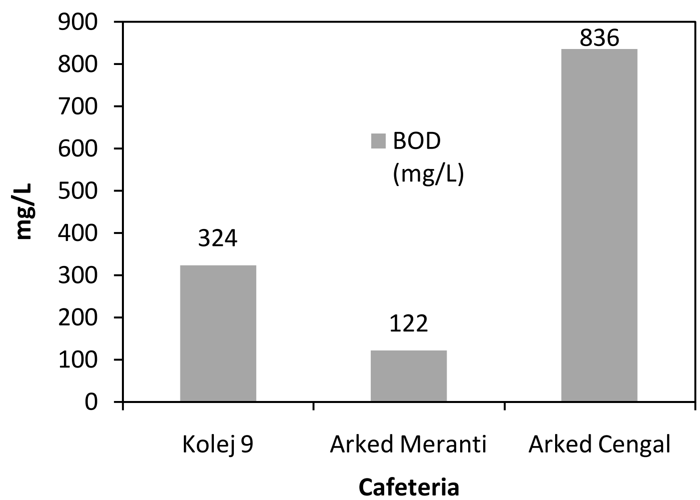

Figure 4.1 : The Current BOD's values at Cafeteria in UTM

The Figure 4.1 shows, the current BOD's values at Cafeteria in UTM. There are Kolej 9 Cafeteria, Arked Meranti and Arked Cengal. The values are slightly different to each other. The BOD value for Kolej 9 was 324 mg/L, 122mg/L for Arked Meranti and 836 mg/L for Arked Cengal. The highest BOD value is Arked Cengal, because of during sampling, a lot of food and others particles. Besides that, the odour and smells were very bad. The smell may from the organic were compose already by bacteria in open drain which produce hydrogen sulphide and methane (Koike, *et. al*,2009).

While the Arked Meranti the lowest BOD's values probably due to sampling doesn't contain any food or organics particles in sullage. Only the dish washes from the sink direct into the sampling containers.

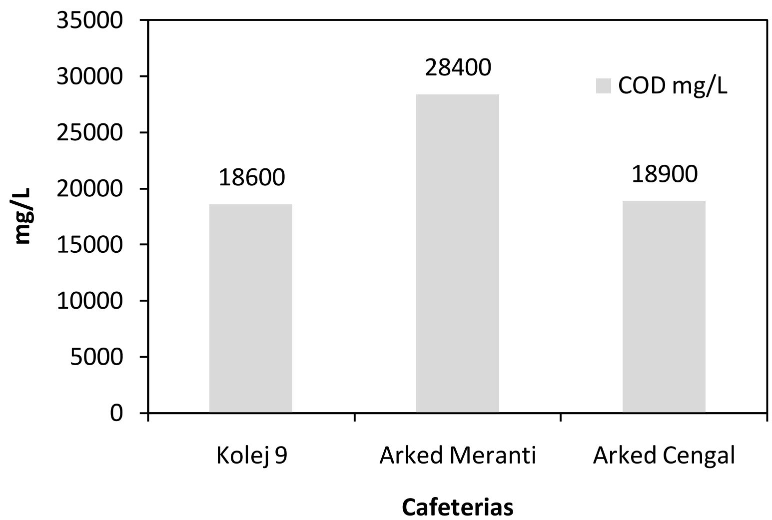

Figure 4.2: The COD's values at Cafeteria in UTM

The COD's values at Cafeteria in UTM are shown in Figure 4.2. The highest value is the Arked Meranti 28400 mg/L followed by Arked Cengal 18900mg/L and 18600 mg/L for Kolej 9 Cafeteria. The COD is a measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite.

However, during sampling the sullage into the container, only the dish washing where collected. It might contain detergent or inorganics chemicals due to dish wash. There were respectively different values due to the source of discharge.

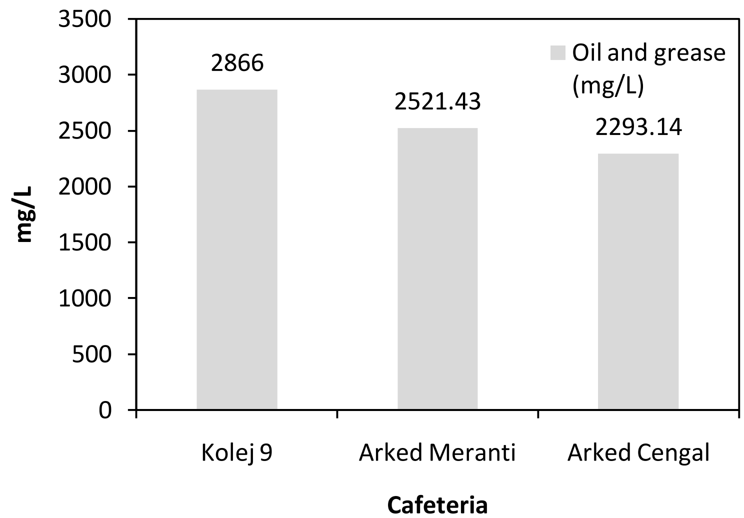

Figure 4.3 : The Oil and Grease values at Cafeteria in UTM

Figure 4.5 shows the current values of Oil and grease values at Cafeteria in UTM. The values of the oil and grease were similar. There were 2866 mg/L for Kolej 9, 2521.43mg/L for Arked Meranti and 2293.14 mg/L for Arked Cengal respectively.

The contributor of the oil and grease is from the cooking oil which the cafeterias are preparing the food. The fat is come from the washing raw animal also contribute the increment values of oil and grease in the sullage. This factor needs to consider controlling to discharge the oil and grease directly into kitchen sink.

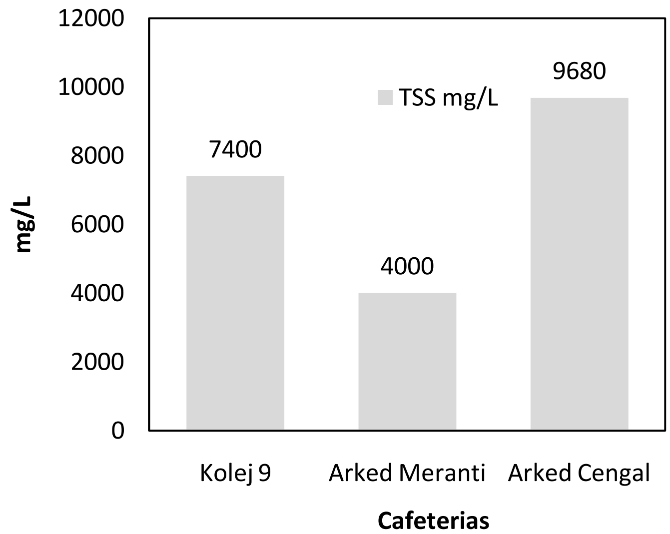

Figure 4.4: The Total Suspended Solid values at Cafeteria in UTM

Figure 4.4 shows the total suspended solid value at cafeteria in UTM. The highest TSS is Arked Cengal, 9680 mg/L. It is related with BOD values was 836 mg/L high in organic and food particles as had discuss. For Kolej 9 cafeteria and Arked Meranti the values are 7400 mg/L and 4000mg/L respectively. The Arked Meranti is the lowest in TSS. However it still need to be reduce until meet the standard of Industrial waste had been declared in parliament in 2009.

During sampling the sullage through into the open drain were already separated the food particle. The caterers at Arked Meranti dump the leftover into dustbin. Only the small particle were attached and been wash with detergent.

4.3 Determination of Garbage Enzyme Dosage.

In preliminary studies, the determination of dosage was only conducted with retaining the sullage in 1 litre beaker and observation for 7 days. Figure 4.5 shows the BOD removal in percentage versus days which is shows the dosage of garbage enzyme obtained after 7 days of retention in sullage dilution. From the figure, it shows that garbage enzyme shows increased removal of BOD with number of days the experiment has conducted.

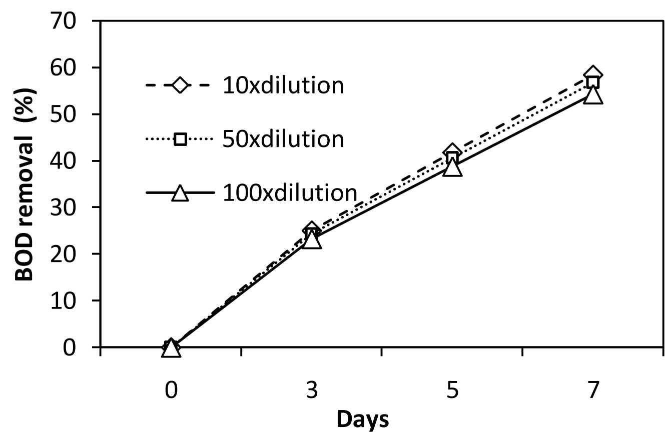

Figure 4.5: BOD Removal Percentage versus days

COD removal graph in Figure 4.6 shows that 10 times dilution of enzyme give highest removal of COD. This is due to the high concentration of enzyme that will help to remove the chemical properties in sullage (Christchurch City Council, 2002). Anthonsen, (1999) had discuss the enzyme work by lowering the activation energy for a reaction, thus dramatically increasing the rate of the reaction. The experiment conducted in room temperature, may also contribute the rate reaction of enzyme.

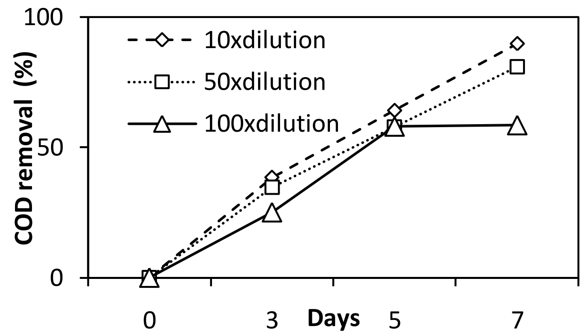

Figure 4.6: COD removal Percentage versus day

Figure 4.7 shows the removal of oil and grease conducted in order to select the best dosage to treat sullage. On the third until fifth day of observation, the removal of oil and grease became stable which show no enzyme reaction with pollutant. However on the 7^{th} day there were some changes that oil and grease where almost 100% for 10 time dilution.

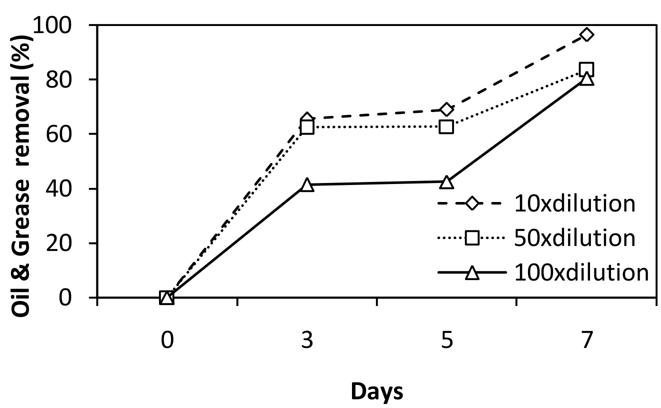

Figure 4.7: Removal of oil and grease versus day

The three parameters had explored shows that the 10 time dilution had a potential result to apply for the treatment. Lastly, total suspended solids (TSS) removal is shown in Figure 4.8. On the third and fifth day of observation, there were slightly different to each other. Unfortunately, on the fifth day the amounts of TSS increased and removal percentage drop suddenly. It may be due to the reaction of enzyme to produce sludge until it settles.

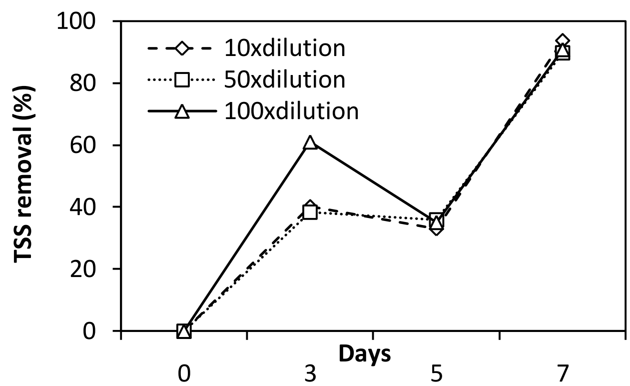

Figure 4.8 TSS removal Percentage versus day

4.4 Comparison Treatment of Sullage between the Cafeterias

In this experiment, sullage was analysed for BOD, COD, oil and grease and TSS. Figure 4.9 below shows BOD result for the sullage before and after treatment of garbage enzyme at various intervals of sample collection from 2nd February to 6th Mac 2010. From the graph, it can be seen that BOD removal increased after treatment with garbage enzyme.

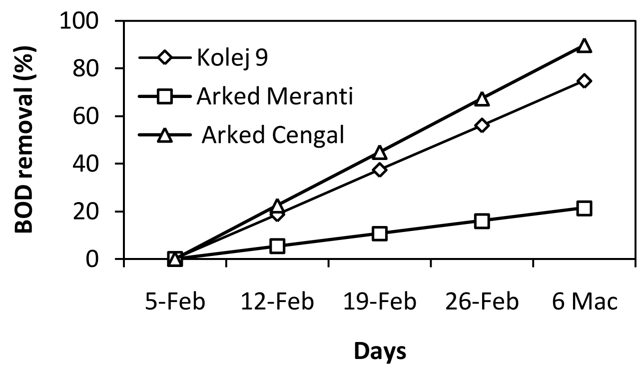

Figure 4.9: BOD removal for sullage collected at Kolej 9 Cafeteria, Arked Meranti and Arked Cengal, UTM

Figure 4.10 shows the COD analysis carried out on the sullage from cafetaria. From the various sampling intervals it shows that COD removal in the sullage increased after treatment with garbage enzyme. On 5th February 2010, COD concentration was 28400 mg/L and was reduced to 1400mg/L after being retained with garbage enzyme from Arked Meranti sullage. COD for Arked Cengal and Kolej 9 Cafeteria were 18600 mg/L and 18900 mg/L respectively and were reduced to 2000 mg/L and 6500 mg/L.

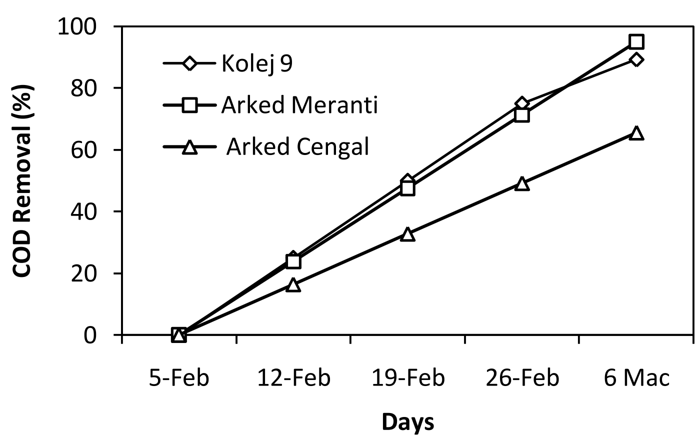

Figure 4.10: COD removal for sullage collected at Kolej 9, Arked Meranti and Arked Cengal, cafeterias in UTM.

Removal percentage on the oil and grease is shown in Figure 4.11. The amount of oil and grease for three cafeterias are similar which is in range of 2800 mg/L. After the treatment and being retained for a month the oil and grease concentration was significantly reduced to 600mg/L. Almost 80% of oil and grease of have been removed by garbage enzyme. Most of the foods produced at cafeteria in UTM are fried and oily, therefore oil and grease are visible in sullage. The reaction of garbage enzyme because of citric acid, acid amino in fruit dreg and the chemical conversion turn carbohydrates, fats and proteins into carbon dioxide and water to generate a form of usable energy. Besides that, the function of the acid is to biodegrade the carbohydrates, fats and proteins (National Institute of General Medical Sciences, 2007) .

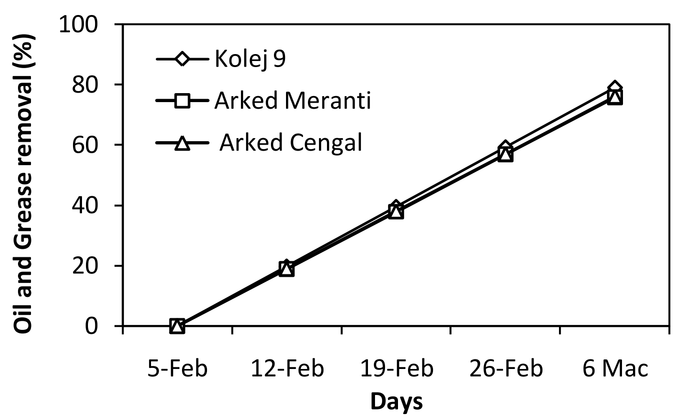

Figure 4.11: Removal of oil and grease at Kolej 9 Cafeteria, Arked Meranti and Arked Cengal, cafeterias in UTM

The removal of TSS in Figure 4.12 is also similar to oil and grease removal. Before the sullage was treated with garbage enzyme, the concentration of TSS at Kolej 9 Cafeteria was 7400 mg/L and the concentration TSS for Arked Meranti and Arked Cengal were 4000 mg/L and 9680 mg/L respectively. After one month being retained with garbage enzyme, the TSS was reduced to 200-350 mg/L. The removal for

TSS is more than 80%, shows that the enzyme works to decrease suspended solid in sullage.

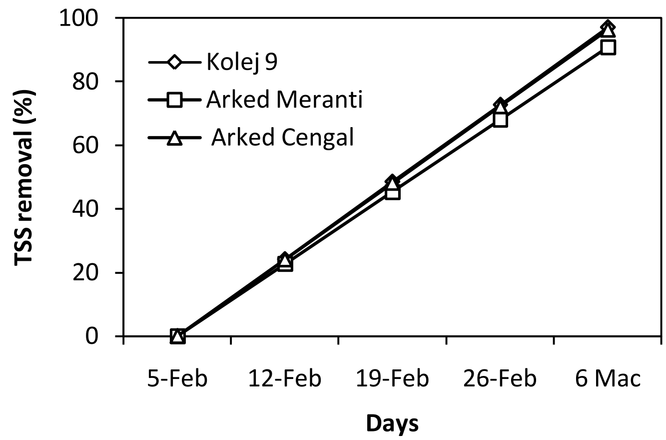

Figure 4.12: Removal of TSS at Kolej 9 Cafeteria, Arked Meranti and Arked Cengal, cafeterias in UTM

4.5 Comparison Treatment of Sullage between the Parameters

Figure 4.13 shows the removal percentage parameters of Kolej 9's sullage. The highest value in removal is Total Suspended Solid (TSS) 97%. Followed by value of COD is 89%, the oil and grease and BOD, 79% and 75% respectively. The removal percentage were significantly, increase which the garbage enzyme react the pollutant. Before the sullage was treating with the garbage enzyme, the sullage contains a lot of particles such as rice grains and silts. The value of TSS was 7400 mg/L then after retains with enzymes the values suddenly drop reach until 216 mg/L.

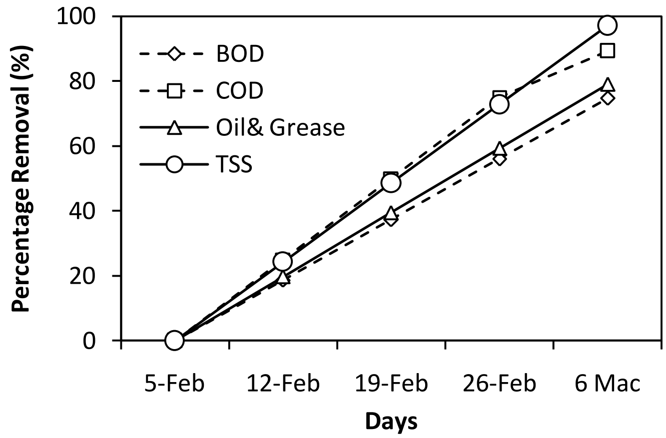

Figure 4.13: Removal Percentage Parameters of Kolej 9's Sullage

The removal percentage parameters of Arked Cengal's sullage are shown in Figure 4.14. The result shows that the TSS also the high removal in treating sullage. There are 96% were removed successfully, followed by BOD removal's 90%. Then 76% and 66% are the oil and grease and COD removal in percentage.

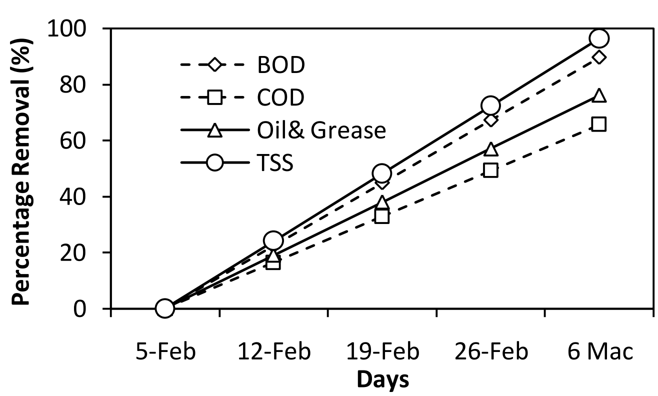

Figure 4.14: Removal Percentage Parameters of Arked Cengal's Sullage

However, there are differences values in Figure 4.15. The COD are the highest among the parameters, in the removal percentage of Arked Meranti's sullage. It was 95% had been removed within retain in a month with garbage enzyme. The TSS's, oil and grease and BOD's values are 91%, 76% and 21% respectively had been removed easily. It is shown that the garbage enzyme can be used to remove and reduce the pollutant easily without any artificial chemical.

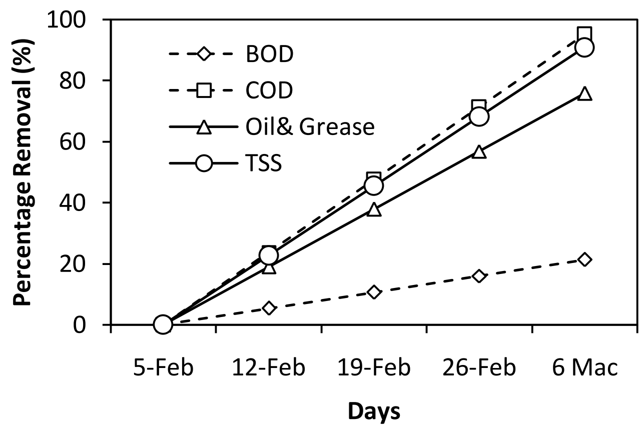

Figure 4.15: Removal Percentage Parameters of Arked Meranti's Sullage

CHAPTER 5

CONCLUSION & RECOMMENDATION

5.1 Introduction

The water quality very important to keep the ecology of environment is balance. Eventough the sullage doesn't have priority in the Environmental Quality (Industrial Effluent) 2009, however it needs to be consider as a point source pollution which came from premises. The study was focussed on the preparation of garbage enzyme from fruits dregs and kitchen waste for sullage treatment. Determination of the current sullage conditions of Arked Meranti, Arked Cengal and Kolej 9 Cafeteria also had obtained. The findings from this study are important to determine whether the garbage enzyme can be applied at UTM's Cafeteria to reduce the amount of pollutant in the sullage.

Based on the data results and discussion of BOD, COD, O&G and TSS parameters where shows an impressive reduction due the high concentration of Garbage Enzyme. There is possibility the enzyme were functioning as a carbon source of bacteria as their food to biodegrade the pollutant effectively.

5.2 Recommendation

Since this study had conducted at Arked Meranti, Arked Cengal and Kolej 9 Cafeteria,it can be applied to all UTM's Cafeteria. It is also suggested that further study will examine from the other viewpoints such as biological characteristic. Besides that, it is strongly recommended that since this study is related to the agricultural activities, further study might also give more focus on the soil contamination that brought through the agricultural activity (planting their plant, fertilization activities) which results in high contamination of nutrients.

Nevertheless, further study is also recommended to widen the scope of the study such as proposed the technique to cope with several problems that occur at UTM's Cafeteria, such as promotes the Garbage enzyme as a cleaning agent to replace the chemical product to improve the water quality.

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