# DEVELOPMENT OF EFFECTIVE MICROORGANISMS MUDBALL MATERIAL FOR WASTEWATER TREATMENT AND MOSQUITO'S LARVAE CONTROL



by

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| | |
|---|---|
| **EM** | Effective Microorganisms |
| **INFRC** | International Nature Farming Research Center |
| **IFOAM** | International Federation of Organic Agriculture Movements |
| **COD** | Chemical oxygen demand |
| **BOD** | Biological oxygen demand |
| **DO** | Dissolved oxygen |
| **POME** | Palm oil mill effluent |
| **R-Strategist** | Species that reproduce early in their life span and produce large numbers of usually small and short-lived offspring in a short period. |
| **BTI** | Bacillus thuringiensis israelensis |

**Kajian Penciptaan Bahan Bebola Lumpur Mikroorganisma Berkesan untuk Rawatan Air Sisa dan Kawalan Larva Nyamuk**


**ABSTRAK**

Mikroorganisma Berkesan (EM), yang ditemui oleh Profesor Dr Teruo Higa, terdiri daripada mikroorganisma yang baik, berfaedah dan bukan patogen ditemui sebagai pendekatan yang boleh dipercayai untuk menyelesaikan banyak masalah alam sekitar meliputi sungai-sungai tercemar, parit, kolam, tasik dan banyak lagi. Sehingga hari ini, isu-isu halal berkaitan sumber EM masih tidak jelas disebut oleh pengilang dan menjadi kebimbangan kepada kebanyakan negara islam seperti Malaysia. Sebagai penyelesaian, sumber berasaskan halal dicadangkan dalam menghasilkan Mikroorganisma Berkesan (EM). Prosedur ujian makmal untuk rawatan air sisa telah dijalankan dengan menggunakan tangki rawatan air sisa yang direka bentuk sendiri dengan merujuk kepada reka bentuk kolam air sisa yang biasa digunakan dalam industri yang mampu menampung isipadu sampel sehingga 30 liter. Untuk percubaan ini, tiga sampel air sisa yang sesuai dari air indah (sisa kediaman), (air Lake) Tasek Melati dan minyak buangan kilang sawit (sisa industri) telah digunakan. Hasil daripada kajian tersebut didapati bahawa bebola lumpur EM mempunyai potensi untuk menyelesaikan masalah rawatan air sisa kerana ia secara positif dapat mengurangkan tahap kekeruhan, keperluan oksigen biokimia, keperluan oksigen kimia, selagi juga dapat menghasilkan pH dan oksigen terlarut pada tahap yang sesuai untuk hidupan akuatik. Untuk air tasik, pengurangan peratusan keperluan oksigen biologi, permintaan oksigen kimia dan kekeruhan adalah 75,91%, 77,87% dan 67,29%. Untuk sisa kediaman, pengurangan peratusan keperluan oksigen biologi, permintaan oksigen kimia dan kekeruhan adalah 74.3%, 78,67% dan 52,74% manakala bagi efluen kilang minyak sawit, pengurangan peratusan keperluan oksigen biologi, permintaan oksigen kimia dan kekeruhan adalah 2.78%, 0.48% dan 0.39%. Keputusan yang diperolehi menunjukkan bahawa bebola EM adalah kurang cekap dalam merawat minyak buangan kilang sawit tetapi ia agak berkesan dalam merawat air tasik dan sisa kediaman. Dalam kajian ini, pengubahsuaian bebola lumpur EM asal telah dibuat dengan penambahan ekstrak herba Malaysia kerana melalui kajian telah membuktikan bahawa tumbuhan ini mengandungi sebatian terbitan, dinyatakan sebagai fitokimia yang mempunyai potensi untuk membunuh larva nyamuk dengan bertindak sebagai keracunan makanan kepada mereka. Bebola EM yang ditambahbaikkan ini boleh membunuh baka nyamuk dalam menyediakan persekitaran yang selamat untuk manusia dan ia telah dijamin selamat untuk semua kehidupan akuatik lain. Eksperimen telah dilakukan untuk menguji kebolehan tiga bebola lumpur EM yang berlainan jenis dalam membunuh larva nyamuk. Kemudian, eksperimen lanjut dijalankan untuk menguji sama ada kuantiti ekstrak herba Malaysia adalah mempengaruhi kecekapan membunuh larva nyamuk. Keputusan yang diperolehi menunjukkan 80% (8 daripada 10 larva nyamuk) larva nyamuk mati untuk 25% ekstrak herba yang ditambah berbanding 40% (4 daripada 10 larva nyamuk) larva nyamuk mati untuk 15% ekstrak herba yang ditambah dan 30% (3 daripada 10 larva nyamuk) larva nyamuk mati untuk 5% ekstrak herba ditambah.

**Development of Effective Microorganisms Mudball Material for Wastewater Treatment and Mosquito's Larvae Control**

## ABSTRACT

Effective Microorganism (EM), discovered by Professor Dr. Teruo Higa, consists of effective, beneficial and non-pathogenic microorganisms was found as the credible approach to solve many environmental problems regarding the polluted rivers, drains, ponds, lakes and so many more. Until today, the *halal* issues caused by the ingredients of EM still are not clearly mentioned by the manufacturer and becomes a concerns to most of the islamic country like Malaysia. As the solution, *halal* based source are suggested in utilization of Effective Microorganism (EM). The laboratory test procedure for wastewater treatment was done by using own design of wastewater treatment tank by referring to common wastewater design pond in industrial which are able to run the samples up to 30 liters. For this experiment, three suitable wastewater samples from Indah Water (residential waste), Tasek Melati (Lake water) and palm oil mill effluent (industrial waste) were used. The result of the experiment shows that EM mudball has the potential to solve the problem regarding treating the wastewater as it positively reducing the level of turbidity, biological oxygen demand, chemical oxygen demand, as long as also being able to work with pH and dissolved oxygen of applied sample in getting the level which suitable for aquatic life. For lake water, the percentage reduction of biological oxygen demand, chemical oxygen demand and turbidity is 75.91%, 77.87% and 67.29%. For residential waste, the percentage reduction of biological oxygen demand, chemical oxygen demand and turbidity is 74.3%, 78.67% and 52.74% while for the palm oil mill effluent, percentage reduction of biological oxygen demand, chemical oxygen demand and turbidity is 2.78%, 0.48% and 0.39%. The results obtained shows that EM mudball are not very efficient in treating palm oil mill effluent but it is quite effective in treating lake water and residential waste. In this work, a little modification of original EM mudball was made by the addition of Malaysia's herbs extracts as the finding that this plants contains derivative compounds, stated as phytochemicals which have a potential to killed mosquito's larvae by acts as poisoning food to them. This new modified EM mudball can kill the mosquito's breed in serving the safe environment for human and it is was guaranteed to be safe for all others aquatic's life. The experiment was done by tested the ability of three different type of EM mudball in killing the mosquito larval. Then, the further experiment was runs to test whether the quantity of Malaysia's herbs extracts will influences the efficiency of killing the mosquito larvae. The obtained results has shows for 80% (8 out of 10 mosquito's larvae) of died mosquito's larvae for 25% of herbs extract added compared to 40% (4 out of 10 mosquito's larvae) of died mosquito's larvae for 15 % of herbs extract added and 30% (3 out of 10 mosquito's larvae) of died mosquito's larva for 5% of herbs extract added.

# CHAPTER 1

# INTRODUCTION

## 1.1 Wastewater Problem

Principally, wastewater is defined as water that already been use for any purpose and it consists of foreign matters such as human waste, food residues, oils, soaps and chemicals. In fact, people used water for almost all in the daily activities includes for cooking, hygiene, and also in businesses and industries. If this used water was not being treated, it will become a big problem for the environment and also people will face with the dearth of clean water sources (Baker and Mooty, 1993).

Apart from that above, wastewater also may consist of storm overflow. The majority of people never expects that the rain that runs down the street during a storm are actually being contaminated with harmful substances that wash off roads, parking lots, and rooftops (Baker and Mooty, 1993).

Water bodies that contain impurities which come from irresponsible action when toxic waste was released directly or indirectly into water bodies without a plentiful procedure to eliminate hazardous composition which can influence living things surrounding will cause for water pollution. The consequence of this pollution will give negative outcome to specific species and populations, and also can become harmful to the essential biological societies (Okuda & Higa, 1999).

Bad water quality can resulted for the unbalance of bionomics and human health. Water pollution not only can turn to become dangerous and executed aquatic life, but also it can transfer affection that can expanse rapidly among people, animals and plants. Normally, the death cases cause by diseases of polluted water commonly happens in poor countries such as Africa as people used unprocessed water right from the original sources like river and lake (Water Quality and Treatment, 1990).

The prolonged use of fertilizers and chemicals in farms is also blamed for soil pollution which leads to low crop yield. The sea and other water bodies have not been spared either. Massive oil spills have been witnessed in the recent past. In addition to effluent from industries that finds its way into water bodies, is causing a great imbalance in the water ecosystem. Sea plants are dying as a result of this which in turn affects fish and other sea creatures (Parr & Hornick, 1992).

The present of so much unwanted materials in polluted water sources served for the poor looked environment with muddy problems and also produce the smelly odors (Parr & Hornick, 1992). Managing human and industrial effluents without danger to human health or offensive harm to the essential environment was the exactly major purpose of solving wastewater problems. Handling wastewater practically needed to face with both disposal and utilization (Natural Resources Management and Environment Department, 1992 & George et al, 2014).

## 1.2 Effective Microorganism

Lactic acid bacteria, photosynthetic bacteria, yeast, fermenting fungi and actinomycetes are a culture of coexisting beneficial microorganisms which was established as Effective Microorganism (EM) (Namasivayam & Kirithiga, 2010). Chaudhry and Lqupal (2006) had mentioned that there was five genera of organisms, namely Actinomycetes, Ray fungi, Photosynthetic bacteria, Yeasts and Lactic acid bacteria that functioning together to form a group Effective Microorganisms (Chaudhry & Lqupal, 2006).

The concept of Effective Microorganisms was developed by Japanese researcher named Teruo higa from the University of Ryukyus, who has explained on 80 different microorganisms which have positivity influencing in decomposing organic matter. EM may have a number of applications in different field such as agriculture, livestock, gardening landscaping, composting, bioremediation, cleaning septic tanks, and algal control (Higa, 2003).

Nathan and Robert (2003) who studied about EM in wastewater systems had come out with the results which showed that experiment was undertaken to determine if the application of EM may decrease the volumes of sewage sludge produced in on-site wastewater treatment systems (septic tanks).

Diver (2002) has suggested that the main species of EM including Lactic acid bacteria (*Lactobacillus plantarum, L. Casei, Streptoccus lactics*), Photosynthetic bacteria (*Rhodoseudomonas palustrus, Rhodobacters paeroides*), Yeasts (*Saccharomyces cerevisae, Candida utilis*), Actinomycetes (*Streptomyces albus, S. griesus*) and Fermenting fungi ( *Aspergillus oryzae, Mucor heimalis*) (Sivanan, et al, 2010).

### 1.3 Wastewater Treatment

When pollutants was discharged directly or indirectly into water bodies without sufficient treatment to remove harmful compounds it can lead to water pollution which will affects living plants and organisms . By leaving this problems without serious attention may effect for severe damaging not only to individual species and populations, but also to the natural biological communities (Xin Yang et al, 2009).

There are numbers of method and technology that was introduced for solving problem of water pollution including biological treatment process and chemical treatment process (Advanced Waste Treatment, 2002). Application of some chemical reaction to deal with impurities water is known as Chemical treatment. In industry, the most commonly used chemical process is chlorination by a strong oxidizing chemical, named as Chlorine that was used to kill bacteria and to slow down the rate of decomposition of the wastewater. Chlorination may results in killing the bacterial if the vital biological processes are affected by the chlorine.

Others example for chemical process in treating the water pollutant is oxidizing disinfection, neutralization and coagulation in which oxidizing process used oxiding agent such as ozone for elimination of unwanted materials while neutralization process needed to adjust pH levels back to neutrality by applying either acid or base (Advanced Waste Treatment, 2002). During coagulation process, insoluble end product that was derived from the addition of a chemical reagent became important aspect that serves to remove substances from the wastewater. Commonly used for coagulation chemicals in wastewater treatment is polyvalent metals while lime, certain iron containing compounds and alum are familiar coagulants that have been used (Utility Management, 2004).

Different from chemical treatment process, biological treatment method are using microorganisms instead of chemical reagents. By applying biological treatment, fitting type of microorganisms that mostly bacteria, was used in the biochemical decomposition of wastewater to stable end products. Theoretically, a portion of the waste that converted to carbon dioxide, water and other end products are depends on quantity of microorganisms, or sludge that contains in the wastewater. In fact, the condition of dissolved oxygen available in the wastewater can be the main count for the biological treatment methods been divided either into aerobic or anaerobic processes (Utility Management, 2004).

Focus on biological treatment methods point of view, many research comes out with the used of microorganisms to treat wastewater and it lead to the finding of Effective Microorganisms (EM) as adequate solution. Begun for over 2 decades ago, there are more than one hundred polluted rivers in Japan that was successfully been cleaned up by using EM technology (Higa & Chinen, 1998).

By the work, it is a concrete proves that EM technology can play positive action in environment management as EM technology can also managed to resuscitate aquatic life, bringing back all the fishes and other water life forms and aquatic plants into the treated rivers (Higa & Chinen, 1998).

### 1.4 Mosquitoes Larval Problem

It is a fact that the environment will affects human's health. The clean environment not only ensure for life's comfort, but also for well-being of all community. Over the past century where the environment still virgin without polluted and the source of clean drinking water still available, it has become a reason for human average life span has almost doubled compared to human life span nowadays.

It is a fact that environment can give an effect to human health as when a parts of environment such as air and water, or soil become polluted, it can cause to health disorder (Abbot & Guijt, 1998). In the other hands, an unmanageable environment can also lead to the human health's threatening by providing the suitable condition for the breeding of mosquito.

For the ability of spreading dangerous diseases, mosquitoes are classified as one of the most threatening species living on earth (Kumar et al, 2003). Technically, mosquitoes are preferred easily found stagnant water to breed as in buckets, tires, pools, marshes or containers left around a property (Fradin & Day, 2002).

The life cycle of mosquitoes was found in four phases which called complete metamorphosis that consists of stages known as egg larva, pupa and adult. Both the larval and pupa stages are aquatic, so that it is necessary for the mosquitoes to lay their eggs near water. As the mosquito got the wings, it is actually in their adult stage. To ensure that the larval can survive, female mosquitoes will decide for the right spot to lay their eggs (Fradin & Day, 2002).

Mosquito borne disease has been brought under control over the world, but the danger of new and devastating outbreaks is always present for the main reasons that mosquitoes and the pathogens they carry are able to evolve shield to chemical pesticides and drugs. In order to against such shield, consecutive surveillance is necessary, together with the employment of a combination of control measurement including physical, chemical, biological and social (Ng FASc & Yong FASc., 2000). Larval control is a major component in mosquito control programs and the successful of this work can help in reducing the popularities of mosquito that led to the safety condition for human's life.