# EM Mudball- Alternative Method for Domestic Wastewater from Mawar College, UiTM Shah Alam

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*Abstract*— **Domestic wastewater is one of our main water sources for daily life. But, most domestic waste water are smelly, dirty, blackish in color and full with trash and are not well managed[5]. This led to pollution that causes bad effect to our health and an increased in other living microorganism in the drain such as E-coli, Fecal Streptococcae and Salmonella[2]. To overcome this issue, the absorption method by organic waste could be used which is EM mudball[6]. Effective microorganism (EM) consist a multicultural of anaerobic and aerobic beneficial microorganisms is presently gaining popularity due to its environmentally friendly nature[5]. Method that used to carry out this study is through the laboratory experimental for all consider parameters. The result obtained shows that EM mudball are capable to drastic reduce the COD, turbidity, SS, and color and also pH value start from third week. For COD it reduced to 168mg/L. While for turbidity, it reduced to 28.7 NTU. For suspended solid it reduced to 4.3mg/L, color reduced to 617.7unit PTCO and for pH the value decrease to 8.25 where closer to reach neutral level. But for DO, the values are keeping increasing till 6.3mg/L. Results show that EM mudball has potential to improve the effectiveness of treatment of domestic wastes.**

***Keywords- EM, Domestic Wastewater, DO, COD, SS, Turbidity, Color, pH***

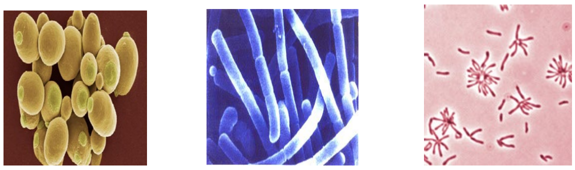
## I. INTRODUCTION

Most domestic waste water are smelly, dirty, blackish in color and full with trash and are not well managed as people dispose the garbage wherever possible, mostly in the drainage systems in rivers [15]. This led to pollution that causes bad effect to our health and an increased in other living microorganism in the drain such as E-coli, Salmonella, and rotavirus[3]. When these wastewater flows to a stagnant trench, the action of various bacteria and other microorganism make the wastewater turn black in color and bad odor smell could be detected. Organic materials within wastewater originate from plants, animals or synthetic organic compounds, and enter wastewater via a number of routes including human wastes, detergents, and industrial sources [19]. Therefore, the application of EM mudball was used[6].

Figure 1: EM mudball

EM mudball is one of the new applications to treat the wastewater [6]. EM mudball is made from mixture of effective microorganism, soil, bio recycle and molasses. EM mudball act as media for the bacteria to growth [18]. After a certain time, as the bacteria growth is shown by surrounded of white pores of algae on the surface of the mudball. So that it can be used. EM mudball has potential to reduce the sludge, reduce the smelly and improve the quality water of the polluted area[7]. This is due to photosynthetic bacteria which it can reduce the smelly produce by polluted water. Apart from that, it may convert polluted water source to fresh water supply source and help the meeting in increasing domestic, industrial and agricultural demand and ensure sustainability of water resource in Malaysia[12].

Effective microorganism (EM) is a culture of coexisting beneficial microorganism predominantly. It is a mixture of groups of organisms that has a reviving action on humans, animals, and the natural environment [22] and has also been described as a multi-culture of coexisting anaerobic and aerobic beneficial microorganisms [18] . They have different function for the treatment of domestic wastewater. Yeast is to break down organic matter, lactic acid bacteria is to neutralize the pH reading and for photosynthetic bacteria is to breakdown the organic and inorganic matter and reduce the smelly[17].



(a) (b) (c)

Figure 2 : (a) Yeast (*Saccharomyces cerevisiae*)[23] (b) Lactic Acid Bacteria (*Lactobacillus casei*) [1] (c) Photosynthetic Bacteria (*Rhodopseudomonas palustris*) [13]

Effective microorganism (EM) is the product most suitable and widely used in Malaysia Rivers is known as EMAS EM1 which frequently being applied in gardening, indoor plants, laundry, and fish ponds [18]. EM charged is safe for plants, humans and animals, and approved for use in organic farming. In the current wastewater treatment process (either municipal or domestic on-site) microorganisms play a significant role in the treatment of domestic sewage. Many different organisms live within the wastewater itself, assisting in the breakdown of certain organic pollutants [4] [14].

As for that, EM is used to treat domestic wastewater in terms of dissolved oxygen (DO), chemical oxygen demand (COD), turbidity, suspended solid (SS), color, pH, volatile organic compound (VOC) and heavy metal and to observe the effectiveness of treating domestic wastewater using EM mud ball technology.

## II. METHODOLOGY

### *A. Materials*

500ml EM-1, 500ml of molasses, 9L distilled water, 1.5kilogram of soil, 1 kilogram of EM bokashi, beakers of 500ml and 250ml, , 2ml pipette and pipette bulb, COD vials with stands, spectrophotometer cuvette, potassium dichromate, sulfuric acid, DO meter, pH meter, COD reactor, turbidity meter, and spectrometer machine

### *B. Methods*

This study has carried out in two different sections in each parameter. The first section is in different volume of wastewater where raw wastewater, SX sample (250ml) and S1 sample (500ml). For the second section, it is continued of raw wastewater and S1 sample for another five weeks. The EM mudball was placed into SX sample and also S1 sample.

i. Preparation of EM Mudball

Firstly, by preparing the EM solution where 250 ml of EM-1 well mixed with 250ml of molasses and also 4500ml of distilled water. Then fill up into an airtight bottle. Then close tightly the plastic bottle and let it be for one week. Bottle cap need to be open once a day due to gas produce by the microorganism which they also have their own excretion process. The fragmentation process take a week to be used as the microorganism has been activating.

The steps of making the EM mudball are mix well EM solution with the soil and EM biorecycle Bokashi until it become damp and easily formed. Next, make a small of the EM mudball where the size is about tennis ball. Then, arrange the EM mudball in room temperature to encourage the growth of fungi and to avoid direct to the sunlight or wind to avoid the EM mudball dries quickly. Then let it be about one week for it to become premature as it has been surrounded with white algae and can be used. Raw water represents of blank sample while sample 1 is represent of treated sample that has been added with the EM Mudball

ii. Chemical parameter analysis

a. Dissolved Oxygen

The wastewater is being poured into the beaker. Then place the DO meter into the beaker. Then read and record the data (IS:3025(Part38)-reaffirmed 2003)

b. Chemical Oxygen Demand

The wastewater is being poured into the beaker. Measure 2mL of the wastewater for raw water and sample wastewater. Then place it into the COD vial containing sulfuric acid and potassium dichromate. Mix well the solution. Then place it into the COD reactor. Set for 150 degree Celsius and 2 hours. After 2 hours, let it cool at room temperature. Then analyze the reading by using spectrometer. Place the COD vial into the spectrometer. Set the COD terms. Set for zero value for distilled water. Then read the value for the raw wastewater and sample wastewater. Record the data. (IS:3025(Part58)-reaffirmed 2006)

c. Suspended Solid

The wastewater is being poured into the beaker. Measure and poured it into the 10mL of spectrophotometer cuvette. Then place it into the spectrometer. Choose the suspended solids terms. Set for zero value by placing the distilled water. Then place the raw wastewater and sample wastewater to determine the value. Then read and record the data. (IS:3025(Part16&17))

d. pH

The wastewater is being poured into the beaker. Then, place the pH meter into the beaker. Then read and record all the data results ((IS:3025(Part11)-reaffirmed 2002)

iii. Physical parameter analysis

a. Color

The wastewater is being poured into the beaker. Measure and poured it into the 10mL of spectrophotometer cuvette. Then place it into the spectrometer. Choose the color terms. Set for zero value by placing the distilled water. Then place the raw wastewater and sample wastewater to determine the value. Then read and record the data.

b. Turbidity

The wastewater is being poured into the beaker. Measure and poured it into the 10mL of spectrophotometer cuvette. Then place it into the spectrometer. Choose the turbidity terms. Set for zero value by placing the distilled water. Then place the raw wastewater and sample wastewater to determine the value. Then read and record the data. (IS:3025(Part10)-reaffirmed 2002)

In addition to Indian Standard, the procedures is also following APHA Standard Methods for the Examination of water and wastewater, 20th edition and also follow the methods for Chemical analysis of water and wastes, EPA-600/4-79-020, USEPA.

## III. RESULTS AND DISCUSSION

Wastewater from Mawar College, UiTM Shah Alam was taken to analyze the characteristics of parameters. The standard values for each parameter are:

Table 1: Average value for each parameter in raw wastewater in five weeks

| RAW WATER | Minimum | Maximum | Average |
|---|---|---|---|
| **Dissolved Oxygen** | 5 | 6.1 | 5.5 |
| **Chemical oxygen demand** | 68.7 | 84 | 76.35 |
| **Turbidity** | 14 | 20.4 | 17.2 |
| **Suspended solid** | 12 | 31.7 | 12.9 |
| **Color** | 128 | 179 | 154 |
| **pH** | 8.45 | 9.9 | 9.2 |

Table 2: Average value for each parameter in sample wastewater in five weeks

| SAMPLE WATER | Minimum | Maximum | Average |
|---|---|---|---|
| **Dissolved Oxygen** | 1.4 | 7.3 | 4.35 |
| **Chemical oxygen demand** | 185 | 196.7 | 190.9 |
| **Turbidity** | 28.7 | 760 | 394.4 |
| **Suspended solid** | 4.3 | 684 | 344.2 |
| **Color** | 617.7 | 4253.7 | 2435.7 |
| **pH** | 7.24 | 8.25 | 7.7 |

The table 1 and 2 are showing the average value for raw wastewater and also the sample wastewater after five weeks treatment. Based on the value, this can be said that the effective microorganism have done certain activities due to high value than in raw wastewater. This shows that the EM mudball shows a good media to treat wastewater. As for the detail value for each parameter, it were explained below.

*I. Dissolved Oxygen*

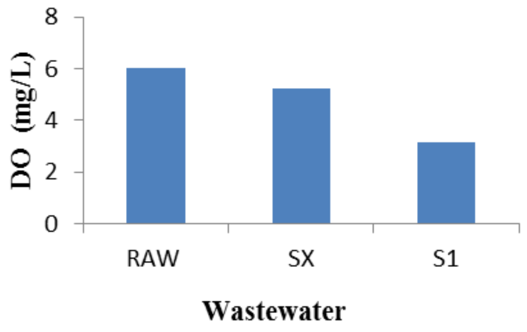



Figure 3: Graph of Dissolved Oxygen (mg/L) versus different type of wastewater

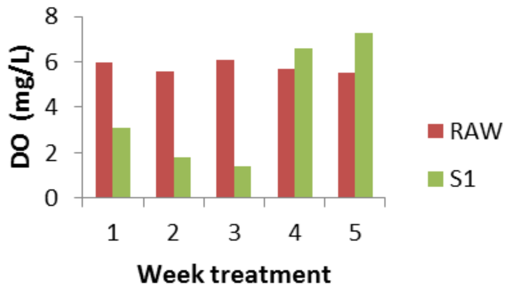



Figure 4: Graph of Dissolve Oxygen (mg/L) versus weeks approach

DO test is used to evaluate the pollution strength of domestic waste water. As the higher values of DO, it may cause corrosion of iron and steel present in the water [19]. Apart of that, algae growth in water may release oxygen during its photosynthesis and DO even may shoot up to 30 mg/l. Dissolved oxygen in the water is important for microorganism growth to capable of oxidizing the biodegradable organic matter in the sample and DO level are depends on the physical, chemical and biochemical activities in the water bodies as the oxygen is considered poorly soluble in water[20]. In higher conditions of temperature, biological impurities, ammonia, nitrates, ferrous iron, chemicals such as hydrogen sulfide and organic matter can reduce DO values [21].

Dissolved oxygen in the raw wastewater is the highest then followed by SX sample and S1 sample. By comparing raw with the SX sample, the DO value shows a slightly different amount where the different of DO value is only 0.8mg/L. This shows that the amount of oxygen diffuse in the raw sample is higher than in the SX sample where highest biodegradation activity to biodegrade the organic and inorganic matter is in the SX sample. The amount of oxygen diffuse in the SX sample is higher than S1 sample. The biodegradation activity in the SX sample is going to end in a week. For S1 sample, the biodegradation activity is going to high due to less amount of oxygen diffuse to degrade the organic and inorganic matter. This shows that the effectiveness of using EM mudball is higher in the SX of wastewater.

DO level for the raw and treated wastewater sample recorded noticeable variations with time. The raw water shows constant amount of DO while for treated wastewater sample show fluttered pattern. This is mainly due to increase oxygen consumption during the oxidation of the included organic matter with the addition of bacteria. Among the data, the treated wastewater sample exhibit the highest biodegradation activity shown as sharp decrease in the DO reaching the lowest level, 1.4mg/l after exposure for three weeks. After two weeks the DO level dramatically increasing as this indicates the end of variable biodegradable capabilities of the organic matter and microorganisms. As the good remarkable data on the week three due to change of DO, this shows that the DO in the wastewater effluent has good ability of inhabiting bacteria for biodegradation and thus oxygen consumption. While for raw water, as the data continuously constant, this shows that biodegradation activity by the bacteria and organic matter is inactive.

By comparing the application of EM mudball on domestic wastewater and textile wastewater from previous studies [20], the amount of DO are keep increasing but dramatically decrease on the day six which A decreased about 30 percent the amount of DO comes with 5.131mg/L from 7.33mg/l on the day six. While by valuating the DO amount on domestic wastewater it continues decreasing until week three. The pattern of the DO value from both result can be said that are closely as the amount of DO will decrease for a certain time due to present of microorganisms. For both applications, the microorganisms start to degrade the organic and inorganic matter on the first weeks where DO value for textile wastewater is 5.131mg/l and for domestic wastewater is 3.1mg/l. The small difference is due to different day of DO value being taken as for textiles is being analyze on day six while domestic wastewater was being analyzed on day seven. By corresponding to decreasing amount of DO, the microorganisms that present from the EM mudball are active as less amount of oxygen being supplied for their pollutant growth.

This shows that, the dissolved oxygen in treated wastewater is imparts freshness as the EM mudball is effective to increase the dissolved oxygen in the wastewater as it can be seen that the amount of dissolved oxygen increase after a time and effective in many applications.

*II. Chemical Oxygen Demand*

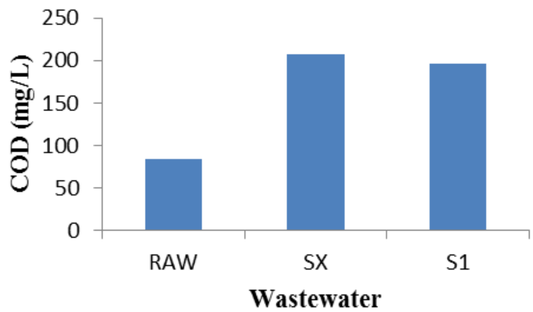



Figure 5: Graph of Chemical Oxygen Demand (mg/L) versus different type of wastewater

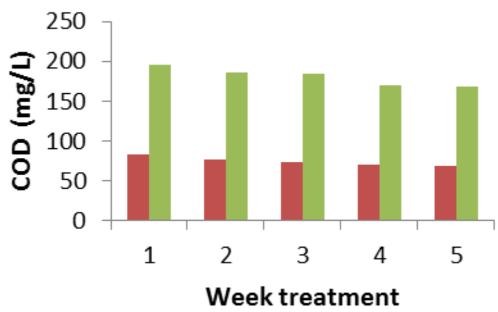



Figure 6: Graph of Chemical Oxygen Demand (mg/L) versus weeks approach

COD is to determine the amount of organic pollutants present in surface water. It also to measure the amount of oxygen in water consumed for chemical oxidation of pollutants. It also determines the oxygen required to oxidize the organic matter in water under specific conditions of oxidizing agent, temperature and time. [17]

The COD value for raw waste water is smaller compared SX and S1 sample. While for SX and S1 sample, the value are close to each other where 207mg/L for SX sample and 195.7mg/L for S1 sample. This shows that the amount of oxygen needed to undergo chemical oxidation by bacteria present in the wastewater are quite same.

While COD values of raw wastewater and for treated wastewater shows minimally decreasing by weeks as there is small differences by weeks. The oxygen required to consume chemical oxidation is decreased by weeks where raw wastewater decrease from 123mg/L to 68.7 mg/l and for the S1 sample, it decreased from 196mg/L to 168mg/L.

By comparing the COD value in the textile wastewater and domestic wastewater from previous research [19], the amounts for both wastewaters were keeping declined. Based on the graph of COD removal in textile wastewater, the percentage removals were markedly increasing just in five days. But for the domestic wastewater, the amounts of COD were slowly decreasing along the five weeks. Even though both applications shows a decrease of COD value, but in textile wastewater shows a faster response which due to present of banana peels that mixed in the EM mudball in the textiles wastewater treatment research that made by previous studies. The mixture of banana peels with EM mudball give a big impact on decreased the COD value.

The EM mudball is quite effective where the amount of COD keep decreasing as more chemical had been degradable by the organism to produce a high quality of source water even in different applications.

Figure 7: Graph of Turbidity (NTU) versus different type of wastewater

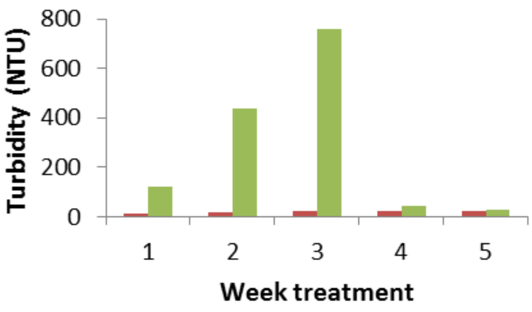


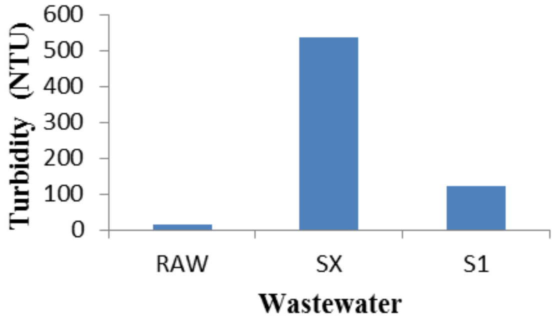

Table 8: Graph of Turbidity (NTU) versus weeks approach

Turbidity is the technical term referring to the cloudiness of a solution and it is a qualitative characteristic which is imparted by solid particles obstructing the transmittance of light through a water sample. Turbidity indicates the presence of dispersed and suspended solids like clay, organic matter, slit, algae and microorganisms[19]

The highest value is SX sample which is 534.67 NTU while the lowest is from raw wastewater which is 14 NTU. This turbidity value can be related as the amount of death cell present in the wastewater. The high amount in SX sample was due to high amount of death cell present compared to S1 sample and raw wastewater. This shows that the microorganism in the SX sample is more aggressive to develop and it is more effective compared to S1 sample and raw wastewater.

The turbidity level for raw wastewater shows a slightly increasing value among the incubation time, while for the treated wastewater show fluctuated pattern where sharply increase for the first three weeks and sharply decrease for the next two weeks. For raw wastewater, the amount of the bacterial decontamination slowly increasing by week. While for treated wastewater, the first three weeks, there were bacterial contaminations as the anaerobe bacteria are develops as it shows the highest amount of turbidity, 760 NTU. While for the lowest turbidity in treated wastewater is 28.7 NTU where the bacterial contamination suddenly decreasing after third weeks. Based on the results, the EM mudball is effective to treat the wastewater as after week three as the turbidity decrease sharply as this is good to have a high quality of source water.

*III. Turbidity*




*IV. Suspended Solid*

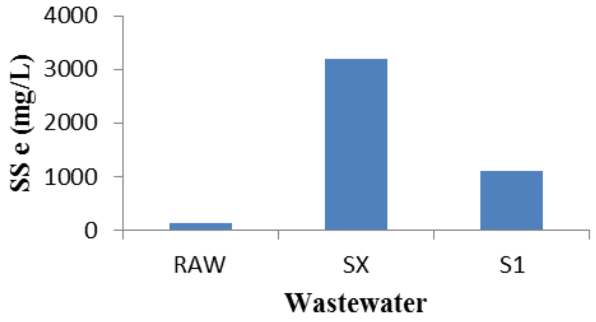



Figure 9: Graph of Suspended Solid (mg/L) versus different type of wastewater

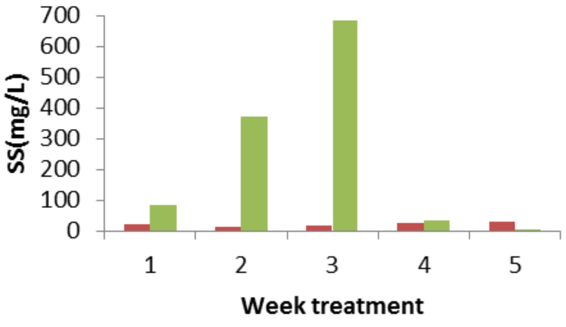



Figure 10: Graph of Suspended Solid (mg/L) versus weeks approach

Suspended material is aesthetically displeasing and provides adsorption sites for chemical and biological agents. Moreover, suspended organic solids which are degraded anaerobically may release obnoxious odors[8]. Biologically active suspended solids may include disease causing organism as well as organism such as toxic producing strains of algae. Suspended solids exclude light, thus reducing the growth of oxygen producing plants [9]

The suspended solid for SX sample wastewater is higher than S1 sample where SX sample with 427.3mg/L while S1 sample is 82mg/L as well as for raw wastewater which is 23mg/L. This is due to death cell present in the water as it can be relate with the amount of turbidity of water. As high amount of suspended solids so the amount of turbidity of the water also high. So, the amount of death cell in SX sample is higher which it is most effective as it can form death cell in shorter time compared to S1 sample.

The suspended solids for raw water substantially increasing by week while for treated wastewater steeply increasing for the first three weeks which from 82mg/L to 684mg/L and then rapidly decreasing for the next two weeks where decrease to 4.3 mg/L. The increasing amount of suspended solids is due to death cell presents in the water as the microorganism had degraded the organic matter. The EM mudball is effective to treat the wastewater as the amount of suspended solids can be reduced due to present of microorganisms.

*V. Color*

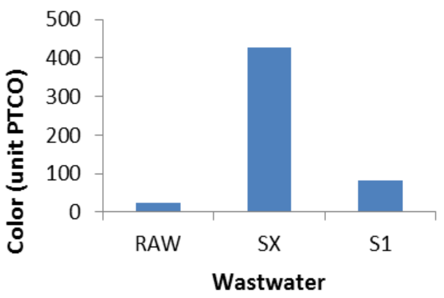



Figure 11: Graph of Color (unit PTCO) versus different type of wastewater

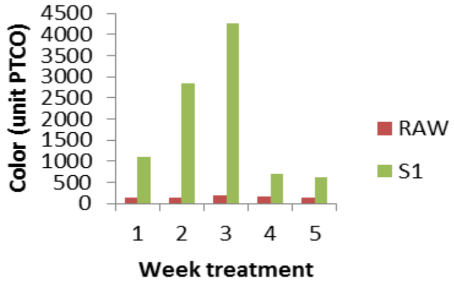



Figure 12: Graph of Color (unit PTCO) versus weeks approach

Color is being determined due to a condition that refers to the age of the wastewater[14]. Color in surface and ground waters results primarily from the presence of natural organic matter, particularly aquatic humid matter. Humid matter consists of humid and fulvic acids where both cause a yellow-brown color. Humic acids give a more intense color, and the presence of iron intensifies the color through the formation of soluble ferric hamates[19]. Suspended particles, especially colloidal-size particles such as clays, algae, iron and manganese oxides, give waters an appearance of color as they should be removed before measurement.

Based on the color appearance, the darkness of the color of the treated wastewater is the highest as it turns into dark gray during week three as this can be relate with the turbidity where this is due to formation of metallic sulfides, which forms as the sulfide produced under anaerobic conditions reacts with the metals in the wastewater. While for the next two weeks, the darkness of wastewater decrease as it turns into light brownish-brown color

.

Color value for SX sample is much higher than in S1 sample and raw wastewater. As from turbidity value, the SX sample has the highest amount compared to S1 sample and raw wastewater value. Based on results, the higher the turbidity value, the higher the value of color of the wastewater. The color present for SX sample is dark gray color while for S1sample is gray color. This shows that the humid matters present in SX sample is higher than other sample. In addition, the effectiveness of EM mudball in SX sample is higher than S1 sample and raw wastewater.

*VI. pH*

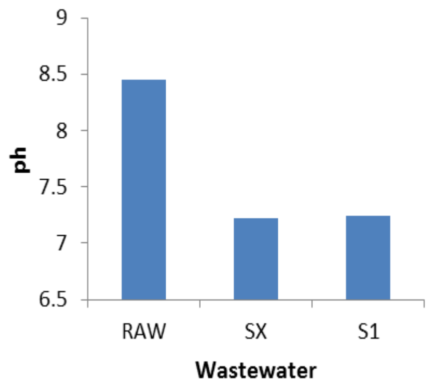



Figure 13: Graph of pH versus different type of wastewater

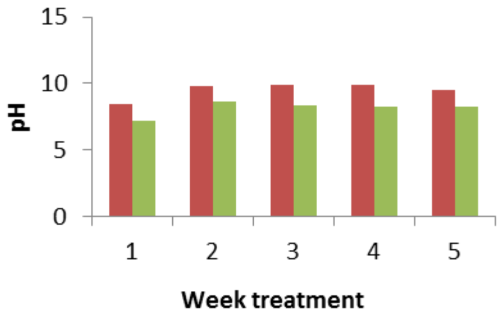



Figure 14: Graph of pH versus weeks approach

pH is a measure of the hydrogen ion concentration in water. As the values lower than 7, it indicates acid while values higher than 7 indicate alkali[10]. In addition, the target water quality range for pH in water for domestic use is 6 to 9 and the target quality range for pH in water for full contact recreation is 6.5 to 8.5. Generally, it can consider satisfactory. Acidic waters tend to be corrosive to plumbing and faucets while alkali waters are less corrosive but above 8.5 may tend to have a bitter taste[11].

pH value for SX and S1 sample of wastewater are in neutral conditions while for raw wastewater, it is in alkali conditions. For the first week, the pH value for both sample treated water are showing a good results as it lower than the amount of pH in raw wastewater. In terms of pH, the effectiveness of EM Mudball is effective for both sample water.

Based on the graph by week, the pH data are increase until week three for raw water while for sample water until week two. Then the pH value decrease for the next weeks. The reason for a relatively low pH value in the water is due to organic material decomposition to form acidic substances but for treated wastewater is still satisfactory range where it keeps decreasing to neutral range. Thus the results that had been obtained for pH measurements in the water were as expected. This shows that, the EM is effective for treated the domestic wastewater as after a fifth weeks the pH keeps on decreasing for a safer uses

pH value in the previous study shows a decreasing pattern that is same as in this research [22]. The Ph values in this research are quite high by comparing to the previous study which is 8.25 while from previous study it reaches 7.1. The previous research reaches the neutral level in 20 days while for this research even though it has been 35 days, the pH still not reach the neutral level where it might due to different of microorganism that being used.

This shows that, the EM mudball is effective to treat wastewater due to decrease of pH value as being expected and being proved by previous research.

## VII. Conclusion and Recommendations

The present study on the quality of sewage wastewater from Mawar College with the treatment of EM technologies reveals that the values are within acceptable standard for each parameter. It could concluded that the EM mudball are capable to reduce the concentration of COD from 196mg/L to 168mg/l, turbidity from 123mg/l to 28.7mg/L, color 1111 unit PTCO to 617.7 unit PTCO, suspended solid 684mg/L to 4.3mg/L. But for DO and ph, the value were increasing where DO from 3.1mg/L to 7.3mg/L and for pH from 7.24 to 8.25. COD, SS and pH are achieving standard B for effluent wastewater by Department of Environmental, Malaysia. EM mudball is effective to treat domestic wastewater.

Apart of that, even though the parameter achieved standard value, the present of sludge in the beaker is not good for our environment as in wide range application it may cause less amount of water produced and can impact on environment.

As recommendation, this study can be advanced in lots of parameter that can be analyzed of its characteristics of the EM mudball in different conditions.

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