SHORT COMMUNICATION

POTENTIAL OF EFFECTIVE MICROORGANISM IN THE TREATMENT OF PIG FARM WASTEWATER

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ABSTRACT. Effective microorganism (EM) is a mixture of beneficial microorganisms that is widely used in agriculture. The microorganisms in EM also show impressive performance in water and waste management by breaking down the organic matters and suppressing the growth of pathogenic microorganisms. This attribute makes EM an ideal solution to treat pig farm wastewater which generally has high organic content. In this study, the performance of EM in treating pig farm wastewater was evaluated from 25 participating local pig farms in Kuala Langat, Selangor, Malaysia. A treatment of 1 litre EM and one mudball was added to each cubic metre of lagoon in the farms. The initial and final Biological Oxygen Demand (BOD) values were measured where the results showed that 23 farms obtained BOD values within the allowable limit. The highest BOD reduction was recorded at 97.32 %. The findings suggested that the application of EM is helpful in treating pig farm wastewater in terms of BOD reduction. Using EM as part of the wastewater treatment routine not only help the farmers to comply with the rules, but also promotes green practices in the livestock farm as the waste can be managed in an effective and sustainable manner.

Keywords: effective microorganisms, pig farm, effluent, water treatment, green practice

INTRODUCTION

Microorganisms are living organisms that cannot be seen with the naked eye, yet they are found everywhere. Among the examples of microorganisms are bacteria, viruses, fungi, and algae. Effective microorganism (EM) is an inoculant consisting of beneficial naturally occurring microorganisms. EM culture is brown in colour and consists of about 80 species of aerobic and anaerobic microorganisms that co-exist at around pH of 3.5 (Wahid *et al*., 2016; Safwat *et al*., 2021). Among the most common microorganisms used in EM are lactic acid bacteria, photosynthetic bacteria, and yeast as shown in Figure 1 (Safwat *et al*., 2021; Mandalaywala *et al.*, 2017).

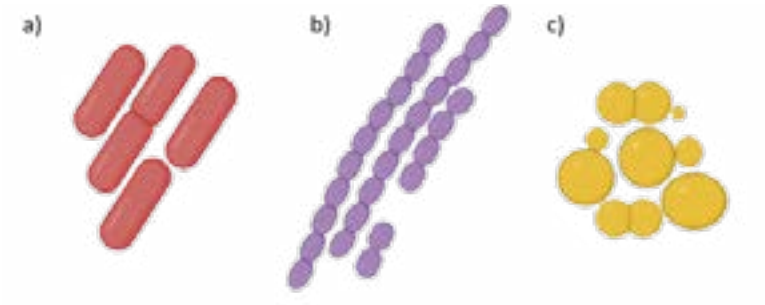

Figure 1. Common microorganisms found in EM; a) photosynthetic bacteria, b) lactic acid bacteria, c) yeast

Developed by Prof. Dr. Teruo Higa, EM was initially used in agriculture for soil application, but it was later found to be useful for various purposes including animal husbandry, bioremediation, wastewater treatment, construction, composting, and household use (Mandalaywala *et al.*, 2017; Jaffar *et al.*, 2014; Siti *et al*., 2016). In animal husbandry, EM can be applied as feed and drink additives which helps to maintain livestock health, sprayed in the barn to control odour and flies, and used in the waste and wastewater management to break down the organic compounds (Maloles *et al.*, 2019; Hidalgo *et al.*, 2022).

EM can be used in liquid or solid form where the solid version is called mudball. In water treatment, EM has shown potential to hinder algae growth, decompose sludge, eliminate pathogens, and improve odour issue while improving the water quality such as total suspended solids (TSS), dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), and pH (Wahid *et al*., 2016; Firdaus *et al*., 2018). According to the Department of Environment (DOE), pig farming is the second largest contributor of pollution load in Malaysian rivers in terms of BOD, suspended solids, and ammoniacal nitrogen (DOE, 2020).

The conventional treatments of pig wastewater are aerobic and anaerobic treatment, composting, flocculation, or/and sedimentation, which however are not enough to remove the pathogens present in pig farm effluent (Bilotta *et al*., 2017). In Malaysia, pig farmers typically divert the wastewater into retention ponds or lagoons before discharging the wastewater into the streams or river. However, the wastewater in such system is minimally treated (Liang *et al*., 2008; Khong, 2014). EM can be an alternative solution in mitigating this problem given its excellent performance in water treatment and bioremediation. Therefore, this paper aims to highlight the potential of using EM to reduce the BOD in the treatment of local pig farm wastewater.

MATERIALS AND METHOD

In this study, 25 small-scale pig farms in Kuala Langat, Selangor, Malaysia were chosen based on simple random sampling. Currently, there are 118 pig farms in the study area where each farm is required to have lagoon system as part of their wastewater treatment process before the farm effluent is released into the environment. Saion Effective Microorganism Activated Solution (Saion EMAS) and mudball were added to the wastewater treatment routine. The EM was sourced from recycled ingredients of natural origin which can be found in food. For each cubic meter of the lagoon, 1 litre of Saion EMAS and one mudball were added. Figure 2 shows the EM used in the treatment.

Figure 2. The liquid (Saion EMAS) and solid (mudball) forms of EM used in the treatment

After a month, the performance of the EM treatment was evaluated by measuring the BOD of the final effluent discharged out of the lagoon. The effluent sample was collected in a 1,000 mL HDPE bottle and kept at 4°C during transportation. The BOD value was determined in the laboratory based on the standard five-day biochemical oxygen demand (BOD5) protocol (APHA, 1999).

RESULTS AND DISCUSSION

Table 1 summarizes the performance of EM based on the BOD value in the treatment of pig farm wastewater in the study area. The initial BOD value indicated the BOD before the treatment. The difference in the BOD values between the farms may be due to various factors such as the number of animals, capacity of lagoons, retention time, feed types, and other husbandry practices in the farm. During the study period, all farms involved did not use other additional chemical or biological treatments except the designated EM treatment. However, some farms may have additional pre-treatment equipment such as solid separator preceding the lagoon water treatment system.

Table 1. BOD values of pig farm wastewater treated with EM

Farm	Initial BOD (mg/L)	Final BOD (mg/L)	Percentage of BOD reduction (%)
A	69.70	6.83	90.20
B	447.00	13.47	96.99
C	228.00	18.90	91.71
D	67.00	25.28	62.27
E	70.50	25.60	63.69
F	104.00	30.00	71.15
G	166.70	30.30	81.82
H	80.00	31.70	60.38
I	101.70	32.10	68.44
J	109.00	32.70	70.00
K	90.00	33.00	63.33
L	174.00	33.60	80.69
M	66.90	34.05	49.10
N	67.00	35.00	47.76
O	585.00	36.00	93.85
P	60.00	36.45	39.25
Q	51.70	36.60	29.21
R	81.80	37.50	54.16
S	171.00	40.60	76.26
T	67.00	42.15	37.09
U	84.00	48.54	42.21
V	93.00	49.70	46.56
W	464.00	50.00	89.22
X	76.00	51.60	32.11
Y	2682.00	71.80	97.32

The Emission or Discharge of Pollutants (State of Selangor) Regulations 2012 under the Selangor Water Management Board Enactment 1999 stated that the standard limit of BOD for pig farming is 50 mg/L. Out of 25 farms, 23 farms (92 %) achieved a BOD level well within the limit. Another two farms; Farm X and Y recorded BOD of 51.60 mg/L and 71.80 mg/L respectively. However, Farm Y showed the highest percentage of BOD reduction of 97.32 % upon the usage of EM.

Besides accumulating toxic pollutants such as pathogens, pharmaceuticals, and metals, pig farm wastewater has high content of organic matter, hence the BOD value can reach as high as 2,000 – 30,000 mg/L (Radhakrishnan *et al.*,

2019; Khairudin *et al.*, 2022). BOD represents the amount of oxygen consumption by aerobic biological organisms to decompose organic matter in the water (Patole *et al.*, 2020). High BOD value may deplete the oxygen content in the water and kill aquatic life such as fish (Radhakrishnan *et al.*, 2019). Lower BOD value signifies that the demand for oxygen is lesser or less oxygen is being removed from the water, and therefore the water is less polluted. The result thus indicated the positive effect of adding EM in the treatment of pig farm wastewater since the majority of the farms obtained a significant reduction in the BOD values.

The reduction of BOD achieved in the pig wastewater treatment may be attributed to the synergistic effect of microorganisms present in the EM mixture. The photosynthetic bacteria act as the detoxifier to decompose the organic matter as they perform incomplete anaerobic photosynthesis while consuming the organic matter (Hidalgo *et al*., 2022; El Shafei *et al*., 2017). Furthermore, the photosynthetic bacteria also remove ammonium to improve the quality of water (Hoo et al., 2021). The lactic acid bacteria consume carbohydrates and transform the sugar into lactic acid by fermentation. It also has the ability to decompose cellulolytic materials and suppress the growth of pathogenic microorganisms by reducing the pH during lactic acid formation (Siti *et al*., 2016; Hidalgo *et al.*, 2022; Joshi *et al*., 2019). Meanwhile, yeast converts sugar into alcohol and breaks down organic matter into carbon dioxide and water (Mandalaywala *et al.*, 2017; El Shafei *et al*., 2017). Various biological active materials like amino acids and polysaccharides to feed the other microorganisms are also produced by yeast (Siti *et al*., 2016). Besides that, the mudballs helped to decompose the sludge as when they were implanted at the surface of the sludge, the effective fermentation by the bacteria will start to break down the sludge (Wahid *et al*., 2016; Joshi *et al.*, 2019).

CONCLUSION

The findings from this study presented the potential of EM in the treatment of wastewater from pig farm. In this study, the usage of EM in the water treatment routine assisted in reducing the BOD value within the allowable limit. This helps prevent environmental pollution from pig farms while ensuring the livelihood of small farmers as their farms' survival depends on whether they can comply with regulations while managing waste effectively. The application of EM also promotes sustainable and green livestock practices because the waste can be managed responsibly. The data obtained from this study are rather limited as this is only preliminary study. Hence, further study should be implemented by covering more farms, testing more parameters such as chemical oxygen demand (COD), total suspended solids, ammoniacal nitrogen, and pH, as well as controlling other parameters that might affect the result such as the animal feed used.

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