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Research Article

Effect of Blend of Enzymes, Organic Catalyst and Probiotics on the Physico-Chemical Properties of Swine Farm Wastewater

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Abstract

The study was performed to determine the effect of the blend of enzymes, organic catalyst and probiotics on the physico-chemical properties of swine wastewater collected from a commercial swine farm in Quezon Province, Philippines. The experiment was composed of four treatments namely: treatment 1 (n=3) no treatment given, treatment 2 (n=3) 25ml of treatment at week one, treatment 3 (n=3) 25ml every week and treatment 4 (n=3) additional 25ml every week. Dissolved oxygen in parts per million was measured daily using an oxygen meter. On the average, results showed that treatment one has decreasing amount of dissolved oxygen while treatments 2, 3 and 4 has increasing amount of dissolved oxygen. Change in color of the water from brown to dark brown and formation of sludge part at the bottom and a supernatant layer at the surface was observed. There were no distinct differences on the turbidity and odor except for the presence of fly larvae in treatments 1 and 2. Statistical analysis showed that there was a significant difference between treatment 1 to treatments 2, 3 and 4. Increase in dissolved oxygen was due to the proliferation of probiotics which increase the rate of decomposition of organic matter in waste water.

Keywords: Dissolved oxygen; Wastewater; Probiotics; Organic matter

Introduction

Wastewater treatment capacity is usually uncommon in low income developing countries which usually resulted to untreated wastewater polluting the streams and rivers used for crop irrigation. This case also calls for health risk reduction. Implementing the supplementary or for some cases, alternative, conventional and non-conventional treatment for the time being is best for reducing the health risk posed by untreated or partially treated wastewater [1]. Swine production in the Philippines is tremendously increasing together with the livestock waste increasing the environmental hazard. In the Philippines, common diseases due to livestock waste were asthma, bronchitis and pneumonia [2].

Dissolved Oxygen (DO) is the level of free, non-compound oxygen in water or other liquids. It is vital to the aquatic life because it is the source of oxygen for the aquatic organisms to survive [3]. Dissolved oxygen comes from the plants which is the primary produced of DO and from the atmosphere. Oxygen in water is consumed through respiration of fishes and aquatic animals, anaerobic bacteria and microorganism respiration during decomposition of organic materials and for chemical reactions in water [4]. DO levels from 0-2 mg/l could not support living organisms, 2-4 mg/ ml could support few amounts of fish and insects, 4-7 mg/ml is acceptable for warm water fish and 7-11 mg/ ml is good for most stream fish including cold water fish [4].

Dissolved oxygen in aerobic lagoon ranges from 0.2-1.8 mg/l for primary treatment. While in anaerobic lagoon, dissolved oxygen is usually not detectable [5].

This study was made to check for the effect of water treatment on a swine farm wastewater using blend of enzymes, organic catalyst and probiotics to hasten the aerobic and anaerobic processes in the water. Also, to provide an alternative way to treat wastewater and to lessen the time and money needed before wastewater to be distributed in bodies of waters like rivers and creeks. This study would increase knowledge about other use blend of enzymes, organic catalyst and probiotics other than as food supplement for animals but as well as wastewater treatment. If this study was acceptable as water treatment, this study could be easily applied in different farms using the pond system as treatment. It could also prevent diseases in swine and human due to improper water disposal and control proliferation of flies in a farm.

Materials and Methods

Preparation of the materials

Bottles: Upon arriving at the area of experimentation, each 5 gallon bottle was opened by cutting the top part of the bottle approximately 3 inches from the cap. The sample was divided into four treatments with 3 replicates for each treatment. The bottle was labelled according to the treatment assigned.

Treatment: blend of enzymes, organic catalyst and probiotics: Blend of enzymes, organic catalyst and probiotics (Oxydol® by Leads Agri Animal Health, Agranco Corp.) is a beige colored powder that contains four micro encapsulated microorganism namely Bifidobacterium longum, Bifidobacterium thermophilum, Bacillus subtilus and Lactobacillus acidophilus with additional enzymes such

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as amylase, protease, cellulose, pectinase and phytase. The probiotic content of the treatment was 90,000,000,000 coli form forming unit per kilogram for each bacteria. The inclusion rate of the treatment is 1 liter of the solution per hectare of wastewater using 1 kilogram of the powder dissolved in 39 litters of non-chlorinated water.

The solution was prepared by mixing one liter of water to 25 grams of blend of enzymes and probiotics (Oxydol®). The solution was mixed until it homogenized and forms a brownish mucoid fluid. It was placed to the samples based on the designated amount given. For treatment 1, no treatment was given. Treatment 2 received 25mL of the treatment once on week 1. Treatment 3 received 25ml of the treatment once a week for four consecutive weeks and treatment 4 received 25ml on week 1 and an additional of 25ml of the treatment for each week until week 4. All the treatment was mixed using a stick for the treatment to disperse and then initial measurement of the dissolved oxygen was performed. Data collection started from January 26 and ended on February 19, 2015. The parameter measured was the amount of dissolved oxygen in parts per million for each samples and observe the physical changes in the wastewater.

Oxygen meter: Oxygen meter (PINPOINT® II Dissolved Oxygen Monitor) was used to measure the amount of dissolved oxygen for each replicate. The process done to measure the wastewater dissolved oxygen was followed according to the manual. Measuring of the dissolved oxygen was performed daily. The unit of measure was in parts per million (ppm).

Statistical analysis: The average dissolved oxygen for each treatment was computed. Using the ANOVA table at 95% confidence interval, all the treatment was compared to check for differences in dissolved oxygen. And using pair wise comparison Student T-test, treatment 4 was compared to treatments 3, 2 and 1 to check for significant differences between treatments. Statistical analysis was performed using Statistical Analysis System.

Results and Discussion

From the experiment performed, the setup mimicked the normal activity in a facultative lagoon wherein it follows a type of lagoon that have an anaerobic part at the bottom which contains the sludge and aerobic part at the surface with supernatant layer (Office of Water Programs California State University Sacramento, 2009). Formation of sludge as well as the supernatant layer at the surface was observed on treatments 2, 3 and 4 on the second week. Generally, there was an increasing amount of DO in treatments 2, 3 and 4. Although, there was a decreasing amount of DO in treatment 1 as shown in Figure 1.

Basically, the anaerobic part of the lagoon contains bacteria which are responsible for decomposition of organic matter to gaseous end products. Facultative bacteria control the degradation of carbohydrates, proteins and fats to organic acids [6]. In this study, probiotics (Bifidobacterium longum, Bifidobacterium thermophilum, Bacillus subtilus, Lactobacillus acidofillus and Streptococcus faecium) were supplemented. These bacteria were responsible for bioremediation or bioaugmentation (breaking down of pollutants or waste by the microbes) and biocontrol (antagonistic effect to pathogens in water) [7]. There have been studies to improve the quality of water quality using probiotics but these studies were mainly used in aquaculture [8]. Swine wastewater used was mainly

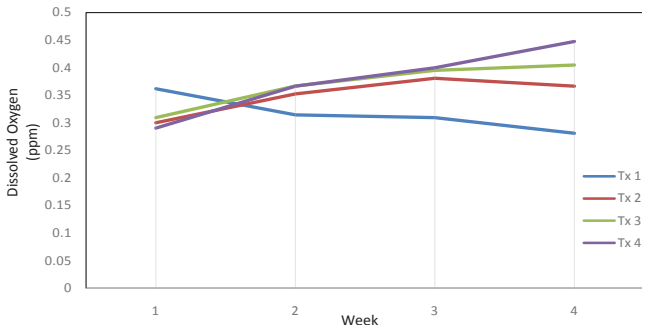

Figure 1: Effect of each treatment on Dissolved Oxygen (DO). (Treatment 1, negative control; Treatment 2 received 25mL of the blend of enzymes, organic catalyst and probiotics once on week 1; Treatment 3 received 25ml of the same blend but applied once a week for four consecutive weeks: and Treatment 4 received 25ml of the blend on week 1 and an additional of 25ml for each week until week 4).

composed of accumulated manure and feeds flushed from pens. Literature says that probiotic bacteria directly uptake or decompose the organic matter or toxic material in the water thus, improving water quality [9]. Enzymes present in the treatment may speed up the process of decomposition as well breakdown organic compounds.

The supernatant layer at the surface is mainly composed of light solids and algae. As observed from all the treatments, there was growth of greenish brown which is a possible to be algal growth at the surface area of the wastewater. Growth of these algae is due to the presence of food such as phosphorus and nitrogen which are in high amounts in feces of pigs. Death of an algae forms into an organic matter which is a source of food for bacteria though the use of oxygen. When there is excessive death of the algae, the bacteria that feed on its organic matter for decomposition is not enough until there was depletion of dissolved oxygen in the wastewater [10]. Therefore, the decreasing amount of oxygen in treatment 1 could be due to consumption of these algae and organic matter of the dissolved oxygen and without the help of additional microorganisms such as probiotics to help degradation of organic matters. On the other hand, the increasing amount of dissolved oxygen in the remaining treatments was due to the supplementation of bacteria that were responsible for decomposition of organic matter and these bacteria does not require oxygen to perform these processes.

Increasing amount of probiotics which were mainly anaerobic and facultative anaerobes were performed in the experiment. The increasing amount of probiotic in wastewater increases bacterial antagonism through bacterial exclusion between resident bacteria within the treatment thereby probiotics modify the microbial community of the wastewater. According to Balcazar et al. [11], microbial community of the water could be altered by different husbandry procedures thus stimulate the proliferation of selected bacteria. Increase in amount of dissolved oxygen could be due to proliferation and alteration of normal flora to probiotics that were mainly anaerobes and facultative anaerobes. Given that anaerobic and facultative anaerobic bacteria require no or little amount of oxygen, these bacteria could still perform decomposition of organic matter present in water without using oxygen. According to literature, these anaerobic bacteria, i.e. Bacillus sp., have high potential solution for environmental pollution and degradation due to presence of

life without the presence of oxygen through production of their enzymes to allow utilization of contaminants as food [12]. Also, beneficial microbes can be used to alter and regulate the composition of the bacterial flora resulting to improvement of water quality through reduction off waste ions, acceleration of mineralization and nitrification, reducing algal growth and accelerating sediment decomposition [13]. Presence of additional enzymes such as amylase, pectinase, phytase, protease and cellulase in the treatment given could help the processes involved to these bacteria. Higher levels of dissolved oxygen could be due to mineralization action of probiotics to organic matter [9].

Fly larvae of an insect which could be Musca domestica were seen to be more distinct at treatments 1 and 2 at week 3 which could indicate that those treatments have higher amount of decomposing material. These maggots are with a life span of 14 to 36 hours saphrophagous larvae wherein they fed on dead and decaying organic matter such as garbage and feces [14]. A study showed that the growth rate of the flies and larva could be attributed to the nutrition provided to it. High nutritive value of the food encourages the fly and larva to consume more food thereby increasing its weight. The life span of the maggots is around to 14-36 hours which could imply that there was continuous life cycle of flies up to week 3 onwards. The odor, on the other hand, is due to low dissolved oxygen on the water. The sludge part contains the resident anaerobic bacteria which by process of breaking down the organic matter from sludge expel hydrogen sulfide which is responsible to the rotten egg smell of the wastewater [15]. With the presence of probiotics altering the microflora of the wastewater, breakdown of the organic material was faster and less number of anaerobic bacteria releasing the foul odor. There were no significant changes and differences on the turbidity of the water. Turbidity in water is caused by the interference of suspended matter like organic or inorganic matter, colored organic compounds or microorganisms resulting to scatter and absorb the light instead of a straight line [16]. Therefore, the decomposition is not enough to remove the suspended matter in the wastewater for it to be clear.

Statistical analysis using the ANOVA table showed that at 5% level of significance, there were differences between treatments 1, 2, 3 and 4. Comparison between treatments was computed using Student T- test and results showed that there was no significant difference between treatments 2, 3 and 4. Although, there was a significant difference between treatment 1 and all the other treatment groups. No differences were found in treatments 2,3 and 4 in this experiment and this could be due to the similarity or closeness of the amount of treatment given although, the treatments have increasing amount of dissolved oxygen. For cases of high eutrophication and very low dissolved oxygen, the treatment that should be given to have significant difference on the amount of dissolved oxygen should be 4- 5 times higher from the initial dosage given [17].

Conclusion and Recommendation

In conclusion, the blend of enzymes, organic catalyst and probiotics on the wastewater has an effect by increasing the dissolved oxygen and helping the organic matter present to decompose faster. The probiotics alter the normal bacterial flora of the wastewater instead of the virus, pathogenic and antibiotic resistant bacteria due to anti-viral and antibacterial effect of probiotics. As of the growth of larvae, which was a major concern in different farms due to proliferation of flies, it could be used for killing the normal habitat of these fly larvae where it complete its life cycle. The foul odor was reduced although the pH of wastewater is recommended to be checked to determine the extent of odor reduction through nitrification and denitrification reactions of the bacteria and probiotics in the wastewater.

It is recommended to measure the amount of sludge present at the end of the treatment to determine which treatment has the greatest amount of decomposition of the sludge. No significant differences were seen on the color and turbidity of the wastewater. Although there were instruments present that measure the changes in turbidity and color of wastewater, visual observation could be enough to evaluate the physical appearance of a wastewater.

This study suggests that wastewater has an effect on the physico-chemical properties of the wastewater by increasing the dissolved oxygen, larva control and reduction in foul smell. Although there was significant difference between treatment 1 to treatments 2, 3 and 4, the difference in dissolved oxygen was very close. This could imply that the desired dissolved oxygen could be achieved without treatment although for those treated with blends of enzymes, organic catalyst and probiotics, the release of wastewater could be earlier by around 6-7 days compared to untreated wastewater. On the other hand, it could also help fly control in swine farms through its larvicidal effect.

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