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Effectiveness of *Moringa Oleifera* as Coagulant for Treating Abattoir Waste Water

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ABSTRACT
Effectiveness of using Moringa oleifera seed for the treatment of abattoir wastewater was studied for the period of five (5) weeks. Completely randomized design with loading dosages of 10, 12, and 14g of processed Moringa seed was used in the treatment. A control (wastewater from abattoir with no Moringa oleifera treatment) was also included. Physical and chemical properties of abattoir wastewater were investigated before and after treatment. The turbidity value was reduced drastically for the treatments from 16.43 mg/l to 11.20 mg/l for 20g treatment particularly in week 5. Total hardness was reduced from 216.67 mg/l to the lowest value at 137.67 mg/l for 10g treatment in the 5th week. Total alkalinity was reduced from 141.3 mg/l to 66 mg/l for the treatments, conductivity was reduced from 1395.7 mg/l to 670 mg/l for 14g treatments just within the first week. The dissolved oxygen was reduced from 6.7 mg/l to zero for the treatments while the BOD was reduced from 4.33 mg/l to zero. The Calcium value was reduced from 30.53 mg/l to 9.40 mg/l for 18g treatment in the 5th week. The results generally showed that the higher the quantity of Moringa oleifera seed applied to the wastewater as week passed by, the better the wastewater treatment.

Keywords: *abattoir wastewater, dissolved oxygen, Moringa oleifera, physio-chemical parameters*

1 INTRODUCTION

An increase in population and commercialization of animal products for consumption has led to an increase in quantities of abattoir waste generated and consequent pollution and degradation of the environment. Most of these wastes generated in the abattoirs are not well managed as the wastes are disposed indiscriminately with serious health challenges to those living within the abattoir vicinity (Oruonye, 2015; Sindibu et al. 2018; Obidiegwu et al., 2019). The quality of freshwater is thus threatened because of pollution from these wastes as the wastewater from the abattoirs are usually released from abattoirs directly into the ecosystems without adequate treatment process (Mittal, 2006; Arvanitoyannis and Ladas, 2008) thereby posing serious threats to surface water quality, general environmental safety and health. This has further been worsened by the fact that the amount of domestic, agricultural and industrial wastewater that flows into the world's rivers is increasing at an alarming rate.

The discharge of raw abattoir wastewater to water bodies affects the quality of water particularly by causing a reduction of dissolved oxygen (DO) (Falodun and Rabiu, 2017) and an increase in heavy metal concentration in the water which may lead to the death of aquatic life (Simeon & Friday, 2017). The environmental impact of abattoir wastewater is not only characterized by pollution via surfactants, nitrate and chronic anions but also pathogens, which persist in the soil and reproduce continuously. These pathogens can also be transmitted to humans who are exposed to the water body, making those areas unsuitable for drinking, swimming or irrigation purposes.

There is therefore urgent need for treating these wastewater prior to discharging them into surface water body as being practiced at present. Many coagulants are widely used in conventional water treatment processes, based on their chemical characteristics. The two most commonly used primary coagulants are aluminum and iron (III) salts, according to Okuda et al. (1999). Nevertheless, current studies have pointed out several drawbacks as associating Alzheimer's disease with the use of aluminum salts in treating wastewater producing large sludge volumes (Kumar and Ram 2016; Sundaresan and Anu 2016).

In recent years, there has been considerable interest in the development of natural coagulants such as Moringa oleifera. By using natural coagulants, considerable savings in chemicals and sludge handling costs may be achieved. Moringa oleifera seed kernels are biological coagulant consisting of significant quantities of low molecular weight water-soluble proteins (Saini et al. 2016), which in solution carry an overall positive charge. Moringa oleifera coagulant has been adjudged safe and very effective in removing impurities (Tunggolou and Payus 2017). It has coagulating properties that have been used for various aspects of water treatment such as turbidity, alkalinity, total dissolved solids and hardness (Arnoldsson et al. 2008). However, its bio-sorption behavior for the removal of toxic and heavy metals from wastewater bodies has not been given adequate attention in this part of the globe.

The primary objectives of this study are, therefore 1) to investigate the effectiveness of using Moringa oleifera in the treatment of abattoir wastewater in terms of physical, chemical and bacteriological properties and 2) to determine the optimum dosage of the Moringa oleifera required in treating abattoir wastewater

2 METHODOLOGY

2.1 PREPARATION OF COAGULANT

Matured pods of Moringa oleifera were chosen from dry cracked fruits. The plucked fruits were cracked to obtain the seeds from which were air- dried for 2 days. The shells surrounding the seed kernel were removed using a knife and the kernels were powdered using a mortar and a pestle then sieved using a 600 µm stainless steel sieve size to obtain a fine powder. The fine powder was stored in a sterile plastic rubber and stored in a refrigerator.

2.2 EXPERIMENTAL DESIGN AND LABORATORY ANALYSIS

The experimental design was based on completely randomized design (CRD) and was replicated three times. Twenty (20) litres of Abattoir wastewater sample was fetched from the abattoir was dispensed into 12 beakers. 500ml of abattoir wastewater sample was poured into three of the beakers mixed with 500ml of distilled water with no Moringa oleifera. This was kept as control sample. Three different concentrations of the stock solution, for the loading dose was prepared by weighing 10g, 12g, and 14g of Moringa oleifera powder into beakers containing 500ml of distilled water each. The mixtures in the beakers was stirred using an automatic stirrer at 125rpm for 30 minutes to obtain a clear solution and was left undisturbed to settle for 1 hour. The solution was recovered from the settled sludge by sieving and measured into a 500ml of the abattoir wastewater sample. The solution was mixed for two (2) minutes by gentle shaking to aid in coagulant formation. The solution formed was recovered and subjected to the experimental analysis which took 5 weeks. After collection, the containers were properly stored in a cool dry place and the analysis of the wastewater commenced two hours after collection. The following parameters were determined: temperature, pH, total hardness, turbidity, conductivity, total alkalinity, dissolved oxygen, manganese, zinc, calcium, phosphate, nitrate and biological oxygen demand (BOD).

3 RESULTS AND DISCUSSION

3.1 pH

The average pH of the abattoir wastewater without Moringa oleifera treatment was found to be 6.96 and was dropped to the average of 6.80, 6.78, and 6.76 for 10 g of Moringa oleifera treatment, 12 g of Moringa oleifera treatment, and 14 g of Moringa oleifera treatment respectively, all in the first week. The pH values, however, increased with weeks, as shown in Figure 1, but got reduced as the Moringa oleifera content increased (Figure 1).

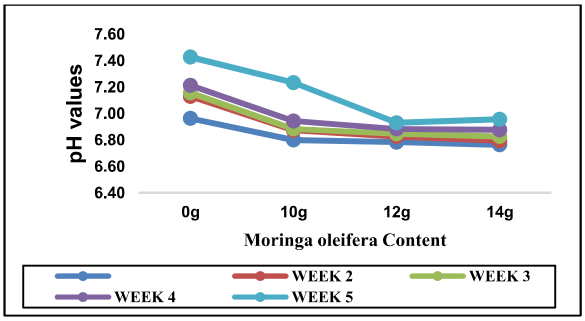

Figure 1: pH values with *Moringa oleifera* treatments

3.2 TURBIDITY

The turbidity at the point of collection was 16.43 NTU. From Figure 2, it can be seen that the average turbidity level reduced rapidly for the control culture across the weeks through which the experiment lasted. With the exception of week 1, the turbidity level of the watewater reduced with increase in Moringa oleifera content throughout the period of the experiment. The average turbidity level ranged from 16.43 NTU in week 1 at the point of collection to 12.80 NTU after 5 weeks of treatment (Figure 2).

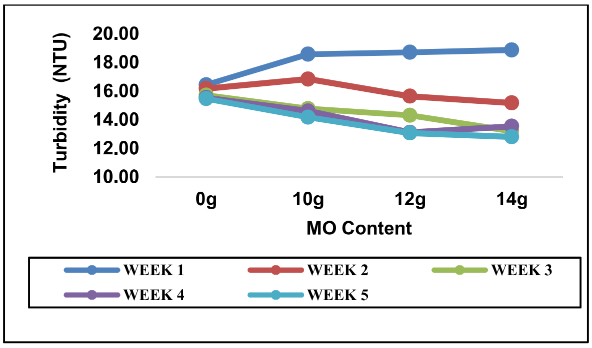

Figure 2: Turbidity values with *Moringa oleifera* treatments

3.3 CONDUCTIVITY

The conductivity of wastewater at the point of sampling (week 1) was observed to be 1395.7 µs/cm and increased with time to 1878 µs/cm in the 5th week. There was drastic reduction in average value of conductivity in the first week. The value at the point of collection was reduced from 1395.7 µs/cm to 670 µs/cm with 14 g Moringa oleifera treatment (Figure 3). This is different in weeks 2 to 5 where the conductivity was observed to increase with weeks, though with gradual reduction with Moringa oleifera treatments (Figure 3).

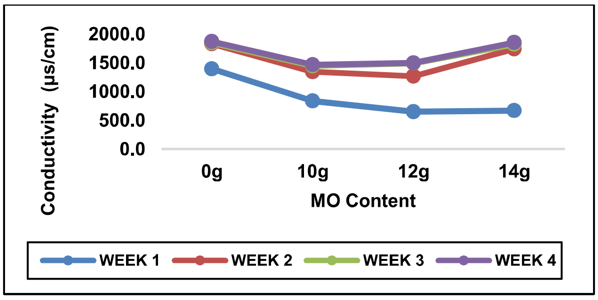

Figure 3: Conductivity values with *Moringa oleifera* treatments

3.4 TOTAL HARDNESS

Initial hardness of all samples at the point of collection was estimated to be 141.3 mg/l. There was general reduction in total hardness across the week from weeks 1 to 5 as shown in Figure 4. The lowest total hardness was observed in the 5th week for 14 g MO treatment (Figure 4). The result, therefore, showed that the higher the quantity of *Moringa oleifera* applied, the higher the hardness that was removed. This is also valid for the period of treatment as it was observed that the total hardness got reduced with time as evident in Figure 4. As a result of this fact, 14 g of *Moringa oleifera* had the highest potency in reducing hardness of wastewater.

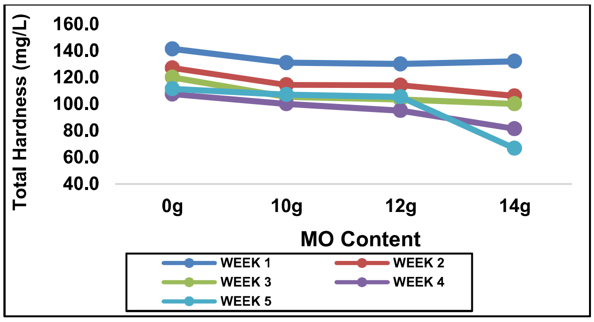

Figure 4: Total hardness values with *Moringa oleifera* treatments

3.5 TOTAL ALKALINITY

Alkalinity at the collection point was 216.67 mg/L. Figure 5 shows that it decreased rapidly in the first week from 216.67 mg/l for control to 86 mg/l at 14 g MO treatment. From Figure 5, in all the weeks, there is general reduction in total alkalinity levels as Moringa oleifera content increased. As a result of this fact, 12 g of *Moringa oleifera* had the highest potency in reducing total alkalinity of wastewater.

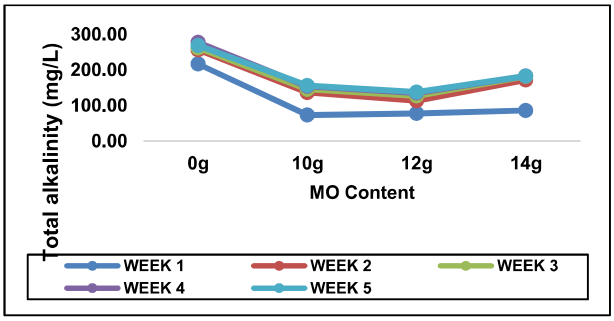

Figure 5: Total alkalinity values with *Moringa oleifera* treatments

3.6 DISSOLVED OXYGEN

Generally, rapid increase in the dissolved oxygen was observed in all the treatments (Figure 6). The dissolved oxygen at the point of sampling was 6.7 mg/l during the week 1 which was gradually improved upon as *Moringa oleifera* content was increased. The suitability of the water for the organisms as evident in the reduced DO proves that the water was conducive to their growth and development. This shows that, wastewater, when treated, can be used for plant irrigation.

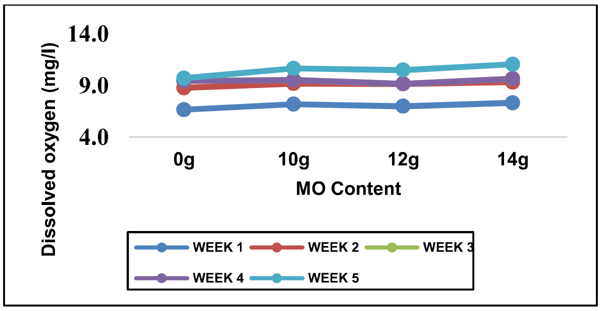

Figure 6: Dissolved oxygen values with *Moringa oleifera* treatments

3.7 ZINC

Zinc as one of the heavy metal in wastewater was observed at the collection point to be 1.42 mg/L, as shown in Figure 7. Figure 7 shows the general decrease in zinc values from week 1 to week 5. The lowest value was observed as 0.62 mg/L in week 5 with 14 g Moringa oleifera content. This shows the efficiency of Moringa oleifera to remove the heavy metal. The zinc content at the point of collection was, however, found to fall below the allowable zinc content in water of 5 mg/L stipulated by World Health Organisation (WHO). The high content of zinc has been attributed to high blood volume found in wastewater.

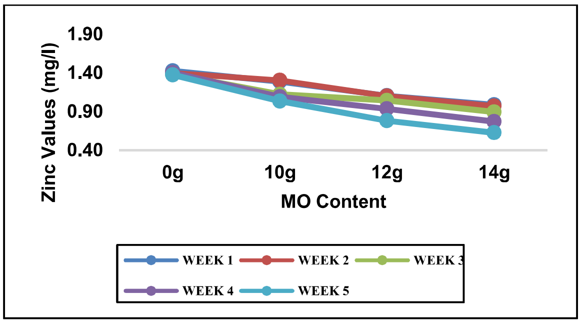

Figure 7: Zinc values with *Moringa oleifera* treatments

3.8 MANGANESE

Manganese, at the collection point, was found to be 0.29 mg/L as shown in Figure 8. The figure shows that it decreased rapidly in the first week from 216.67 mg/l for control to 86 mg/l at 14 g MO treatment. From Figure 5, in all the weeks, there is general reduction in total alkalinity levels as Moringa oleifera content increased. As a result of this fact, 12 g of *Moringa oleifera* had the highest potency in reducing total alkalinity of wastewater.

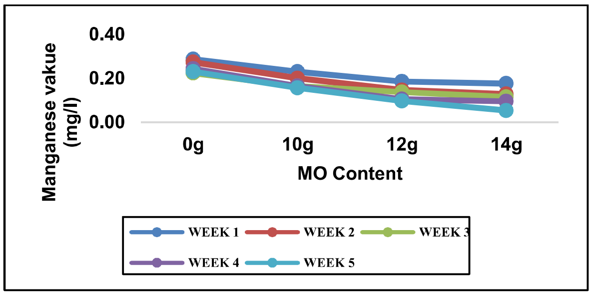

Figure 8: Manganese values with *Moringa oleifera* treatments

3.9 CALCIUM

Figure 9 shows the different levels of calcium content in wastewater from raw wastewater to the treated wastewater with Moringa oleifera. At the collection point, calcium content was found to be 30.53 mg/L as shown in Figure 9, which is moderately soft whci falls within 21 to 40 mg/L for moderately soft water. The value decreased rapidly with the increase in *Moringa oleifera* and the lowest was found to be 9.13 mg/L in week 5 with 14 g *Moringa oleifera* treatment (Figure 9). Hardness of water has been attributed to high concentration of calcium ion and some other elements like magnesium in and some heavy metals, like zinc in water.

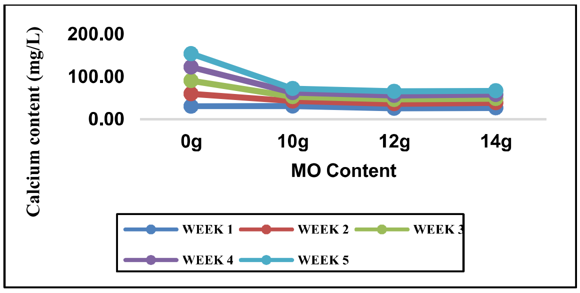

Figure 9: Calcium values with *Moringa oleifera* treatments

3.10 BIOLOGICAL OXYGEN DEMAND (BOD)

Initial BOD value recorded was 4.33 mg/l at the point of sampling. The BOD level was determined by comparing the dissolved oxygen levels of the sample before and after 5 days of incubation in the dark. The difference between the two DO levels gave the required amount of oxygen required for the decomposition of organic materials in the wastewater. Higher BOD concentrations recorded at the point of collection was due to high blood volume in the wastewater. This is in conformity with the finding of Del Pozo *et al*. (2003). This fact had a great influence on the rest of the parameters and the nature of the wastewaters. This, thus, means that during the week 2 all the organic matters present in the wastewater samples have been fully decomposed as shown in Table 1.

TABLE 1: BOD VALUES FOR THE WASTEWATER SAMPLES

Moringa Content (g)	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5
0g	4.33	0.00	0.00	0.00	0.13
10g	4.87	0.00	0.00	0.00	0.00
12g	4.33	0.00	0.00	0.00	0.00
14g	5.33	0.00	0.00	0.00	0.00

3.11 PHOSPHATE

The levels of phosphate and nitrate compounds were higher in wastewater as 2.26 mg/L (Figure 10). This may be attributable to the high fecal contents of the effluents. According to Rodier (2009) reported that wastewater samples must have less than 0.5 mg/l of phosphate before its discharge into aquatic environment. The results obtained in this study showed significant reduction of phosphate concentration from 2.26 mg/L to 0.57 mg/L in week 5. High phosphate levels will result in the eutrophication of the river. Phosphorus in the wastewater originate from stomach contents in the effluent.

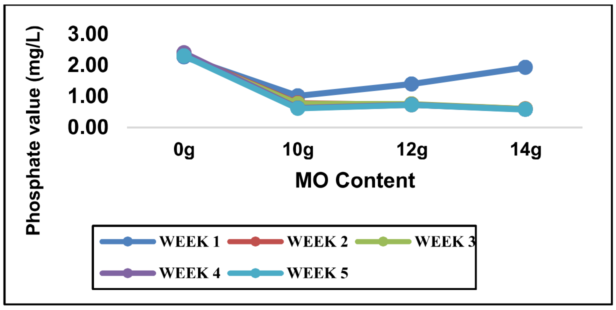

Figure 10: Phosphate values with Moringa oleifera treatments

The efforts of laboratory staff of department of Water Resources Aquaculture and Fisheries Technology for the laboratory analysis is well acknowledged

4 CONCLUSION

Performance evaluation of Moringa oleifera as an environmentally friendly natural coagulant has been assessed. It was observed that Moringa oleifera is suitable for the treatment of wastewater containing undesirable heavy metal concentrations like zinc and manganese. From the experimental analysis and the results obtained, the following conclusions can be drawn:

i Moringa oleifera is an eco-friendly and economically advantageous and available.

ii Moringa oleifera is an effective natural coagulant which can be used in improving the physicochemical characteristics of water in terms of pH, turbidity, total alkalinity, total hardness, dissolved oxygen, BOD, calcium and conductivity.

iii Moringa oleifera seeds present An efficient way of treating abattoir wastewater before being discharged into surface water body. It can also serve as an alternative coagulant to alum in treating water for rural dwellers since they are environmentally friendly and cheaper.

REFERENCES

Arnoldsson, E., Bergman, M., Matsinhe, N., & Persson, K. M. (2008). Assessment of drinking water treatment using Moringa oleifera natural coagulant. Vatten, 64(2), 137.

Arvanitoyannis, I. S., Ladas, D. (2008). Meat waste treatment methods and potential uses. International J. Food Sci. Technol. 43:543-559.

Del Pozo R., Tas, D. O, Dulkadiroglu, H., Orhon, D., Diez. V. (2003). Biodegradability of slaughterhouse wastewater with high blood content under anaerobic and aerobic conditions. J. Chem. Technol. Biotechnol.78:384-391.

Falodun, O. I., & Rabiu, A. G. (2017). Physico-chemical and bacteriological quality of an abattoir wastewater discharged into water bodies in Ibadan, Nigeria and drug resistant profile of isolated Salmonella species. J Microbiol Biotech Res, 7, 23-31.

Kumar, M., & Ram, S. (2016). Chemical Treatment of Water & Wastewater Treatments by Alum. i-Manager's Journal on Civil Engineering, 6(2), 36.

Mittal, G. S. (2006).Treatment of wastewater from abattoir before landapplication – a review. Bioresour. Technol. 97:1119-1135

Obidiegwu, C. S., Chineke, H. N., Ubajaka, C. N., & Adogu, P. O. (2019). Public Health Challenges in Somachi Main Abattoir Owerri, Nigeria: A Review and Field Activity Report. safety, 1(2).

Oruonye, E. D. (2015). Challenges of Abattoir Waste Management in Jalingo Metropolis. Nigeria. International Journal of Research in Geography, 1(2), 22-31.

Saini, R. K., Sivanesan, I., & Keum, Y. S. (2016). Phytochemicals of Moringa oleifera: a review of their nutritional, therapeutic and industrial significance. 3 Biotech, 6(2), 203.

Sindibu, T., Solomon, S. S., & Ermias, D. (2018). Biogas and bio-fertilizer production potential of abattoir waste as means of sustainable waste management option in Hawassa City, southern Ethiopia. Journal of Applied Sciences and Environmental Management, 22(4), 553-559.

Simeon, E. O., & Friday, K. (2017). Index models assessment of heavy metal pollution in soils within selected abattoirs in Port Harcourt, Rivers State, Nigeria. Singapore Journal of Scientific Research, 7, 9-15.

Sundaresan, A., & Anu, N. (2016). Feasibility of Natural Coagulant for the Treatment of Dairy Wastewater. International Journal of Scientific and Engineering Research, 7(4), 245-249.

Tunggolou, J., & Payus, C. (2017). Application of Moringa oleifera plant as water purifier for drinking water purposes. Journal of Environmental Science and Technology, 10, 268-275.