*Scientia Africana, Vol. 22 (No. 2), August, 2023. Pp 287-296*
*© Faculty of Science, University of Port Harcourt, Printed in Nigeria* *ISSN 1118 – 1931*

# TREATMENT OF ABATTOIR WASTEWATER USING *MORINGA OLEIFERA* SEED AND SNAIL SHELL IN RIVERS STATE, NIGERIA

**Anele, B. C.[1,3]*, Okerentugba, P. O.[1], Stanley, H. O.[1], Immanuel, O. M.[2], Ikeh, I. M.[3], Ukanwa, C. C.[3] & Okonko, I. O.[4]**

[1]Department of Microbiology, University of Port Harcourt, Choba, Rivers State, Nigeria
[2]Department of Biological Sciences, University of Africa, Toru-Orua, Bayelsa State, Nigeria
[3]Department of Microbiology, Madonna University Elele, Rivers State, Nigeria
[4]Virus & Genomics Research Unit, Department of Microbiology, University of Port Harcourt, Port Harcourt, Nigeria.
ORCID iD: 0000-0002-3053-253X
***Corresponding author:** brightanele76@gmail.com

*Received: 13-08-2023*
*Accepted: 21-08-2023*

https://dx.doi.org/10.4314/sa.v22i2.25

Journal Homepage: http://www.scientia-african.uniportjournal.info
Publisher: *Faculty of Science, University of Port Harcourt.*

## ABSTRACT

*The practice of discharging abattoir wastewater into a receptacle without treatment is most likely to alter its physicochemical and microbiological properties. Against this background, this study is aimed at determining the efficacy of Moringa oleifera and snail shells as bio-coagulants for treatment of abattoir wastewater using the jar. The mean values of monitored physicochemical parameters were electrical conductivity (1227.7), total organic carbon (224.4%), biochemical oxygen demand (362.3 mg/l), chemical oxygen demand (1001.5g), total dissolved solids (462.5 mg/l), total suspended solids (1562.5) mg/l and turbidity (190.6 NTU). The mean total heterotrophic bacteria count (THBC) for untreated wastewater was 1.4 x $10^8$ CFU/ml, total coliform count (TCC) was 5.6 x $10^5$ CFU/ml, and total fungal count (TFC) was 1.6 x $10^2$ CFU/ml. After treatment, the bio-coagulants caused 82.5-84.2% reduction in EC, TOC (59-88.3%), BOD (90.8-93.7%), COD (94.4-95.3%), TDS (89.6-91.9%), TSS (93.3-94.5%) and turbidity (80.8-84.5%). The bio-coagulants were able to remove 92.2-95.4% of Zn, Pb (97-97.5%), Cr (97.2-98.8%) and Cd (86.7-89.3%). After treatment with the bio-coagulants, THBC dropped from 4.7 x $10^3$-5.3 x $10^2$ CFU/ml to 8-10 CFU/ml on day 6, TCC dropped from 4.2 x $10^2$ – 6.7 x 10 CFU/ml to 5-7 CFU/ml on day 6 while TFC dropped from 1.1 x 102 - 1.5 x 10 CFU/ml to 2-4 CFU/ml on day 6, representing approximately 99.9% reduction in microbial load. Thus, the bio-coagulants were as good at removing pollutants in water as alum, but with the added advantages of being natural, cost-effective, and readily available.*

**Keywords:** Biocoagulants, *Moringa oleifera*, Snail shell, Abattoir

## INTRODUCTION

An abattoir or slaughterhouse describes a location where animals are killed for meat (Tamenech & Tamirat, 2017). Abattoirs are usually sited in a location where there is a large population of human residents for the purpose of meeting their needs for animal protein. Intensive efforts geared towards boosting meat production to meet the increasing demand by the populace without observing strict regulations could lead to pollution of air, soil and water (Abubakar, 2014).

There are numerous waste-generating sources and waste-handling alternatives at the abattoir complex. Abattoirs in many countries operate under unsanitary conditions and often discharge their waste into the environment without treatment. To worsen the situation, the regulatory bodies saddled with the responsibility of enforcing sanitary conditions and proper waste disposal in the abattoirs are inefficient (Adzittey *et al*., 2010; Mohammed & Musa, 2012)

Faeces, blood, bone, hone, fat, animal trimmings, paunch content, urine from operations, stunning or bleeding, corpse processing, and by-product processing are just a few of the contaminants found in abattoir wastes (Aniebo et al., 2009; Nwachukwu et al., 2011).

Lack of implementation of good manufacturing practices during meat processing to ensure that hygienic conditions are maintained at all times in the abattoirs in many underdeveloped countries pollutes the environment (Sumayya et al., 2013; Abubakar, 2014).

In undeveloped countries, abattoirs are typically located near bodies of water for easy access to water for washing. Workers in the abattoirs usually dump wastewater from the abattoirs into the nearby water bodies without any type of treatment (Neboh et al., 2013; Ogbomida et al., 2016)

This practice compromises the safety and quality of the water bodies which endangers human health and aquatic life (Ogbomida et al., 2016). Pollution of water bodies pollution is a serious environmental problem, especially in developing countries with widespread ineffective waste management and garbage discharge into waterways, which can be worsened by abattoir waste (Tamench & Tamirat, 2017). Due to the size and significance of meat processing industry, large quantities of wastewater are generated every day, which should meet discharge standards before being released into the environment. To protect the environment and the people that live there, wastewater treatment is a crucial part of a sanitation system. Conventional treatment approaches might frequently involve a variety of coagulants to lessen or reduce the detrimental effects on the receiving environment. The practicability of treating abattoir wastewater in most underdeveloped countries is hindered by the cost of treatment. One component of the cost comes from the use of chemical coagulants, which are often expensive and have an effect on the environment (Deborah et al., 2018).

Bio-coagulants on the other hand are easily accessible and affordable, in addition to being biodegradable, yet, have excellent coagulation-flocculation potential (Nwabanne & Obi, 2019; Okey-Onyesolu et al., 2020). The effectiveness and safety of natural coagulant system biomasses are currently being considered since they are environmentally friendly by nature. *Moringa oleifera* seed can safely be used as a coagulant and is good at removing pollutants from water (Adeniran et al., 2017). The drumstick tree, horseradish tree, benzolive tree, and kelor tree are some of the common names for *Moringa oleifera*. It is the member of the family Moringaceae's genus Moringa that has been the subject of the most research. There are 13 other species of the genus Moringa that are recognized (Ibiene et al., 2021). The plant is indigenous to the tropics and has been found in South America, Asia, and Africa. Due to its many uses, M. oleifera has been called a "miracle plant" (Ibiene et al., 2021).

It is a flexible crop with importance in nutrition, medicine, and the environment,

*Scientia Africana, Vol. 22 (No. 2), August, 2023. Pp 287-296*
*© Faculty of Science, University of Port Harcourt, Printed in Nigeria* *ISSN 1118 – 1931*

particularly in developing nations. In many poor nations, it is not only eaten as a vegetable but also as a significant source of vegetable oil (Ibiene et al., 2021). More so, because it also has good bioabsorption properties, a snail shell is a strong candidate for use as a bio-coagulant (Nwabanne & Obi, 2019). This study aimed to assess the suitability of using *M. oleifera* and snail shells in the treatment of abattoir wastewater.

## MATERIALS AND METHODS

### Study Area

Port Harcourt is a metropolitan city and the administrative capital of Rivers State, located in the southern part of Nigeria. The city has a population of over 10 million. It is the nucleus of the oil and gas industry in Nigeria. The climate is humid tropical rainforest, with 8-10 months of wet season and 2-4 months of dry season. The indigenous population engage in trade, fishing and farming, before the entry of explorers and missionaries, but are now more engaged in white- and blue-collar jobs as available in the city. Several abattoirs located in the city, including those at Chokocho-Etche, Mbodo-Aluu, Rumuokoro, and Trans-Amadi provide meat processing services.

### Sample Collection

Samples of *Morinaga oleifera* seeds, snail shells and alum were obtained from Mbodo-Aluu and Etche Markets Wastewater samples were collected from abattoirs located at Chokocho-Etche, Mbodo-Aluu, Rumuokoro, and Trans-Amadi. The samples were collected using sterile sample vials and taken to the laboratory for analysis and treatment.

### Processing of *Moringa oleifera* and snail shell

Seeds of *M. oleifera* were sun-dried for five days and ground into powder using an industrial blender (Maduabuchi, 2018). Snail shells were washed with water and sun-dried for five days, crushed using a pestle and mortar, further air-dried for three days and ground into powder (Stanley et al., 2020).

### Physicochemical Analysis

The pH of wastewater samples was determined using a pH meter while the temperature, conductivity and turbidity of the samples were determined using handheld multiparametric meter (Hana), respectively. Biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), total suspended solids (TSS), total dissolved solids (TDS) and chloride concentrations were determined by the method described by APHA (2005). Heavy metal concentrations were determined using Atomic Absorption Spectrophotometer (ASS).

### Microbiological Analysis

Enumeration of bacterial and fungal population in the wastewater samples were carried out using pour plate method as described by Aneja (2013). Nutrient agar plates inoculated with the sample was used to determine total heterotrophic bacterial count (THBC) while potato dextrose agar plates were used to determine the total fungal count (TFC). The method described by Prescott et al. (2005) was used for the determination of total coliform count (TCC).

### Coagulation Experiment

The coagulation-flocculation experiments were carried out using a jar test approach (Ali et al., 2010). The abattoir wastewater samples were well agitated to obtain a homogeneous mixture and fractionated into 250 ml beakers. Five (5g), 15g and 25g of *Moringa oleifera*, snail shells and alum coagulants were added to each beaker containing the wastewater.

Afterwards, the beaker was first agitated at 250 rpm for 2 minutes and then at 30 rpm for 20 minutes, and was allowed to settle for 30 minutes. Afterwards, a portion of the water was collected at a 2 cm depth beneath the surface of the water, using a sterile pipette, and used for microbiological and physicochemical analyses.

### Effect of wastewater on plants

To ascertain the effect of treated and untreated abattoir wastewater on the plant, already germinating waterleaf (*Talinum fruiticosum*) plants were watered for three weeks, and thereafter, their growth parameters were measured.

### Statistical analysis

Descriptive and inferential statistics were used for results representation and interpretation. ANOVA for the various physicochemical and microbiological parameters of wastewater samples was calculated at 95% confidence interval and p value < 0.05 was considered significant.

## RESULTS

Table 1 shows the mean values of monitored physicochemical parameters in sampled abattoir wastewater. After treatment, electrical conductivity ranged from 194.5±60.2-214.5±69.9 μs.$cm^{-1}$, TOC 91.2±12.95-72.3±24.3%, BOD 32.4±3.1-22.9±2.8 mg/l, COD 55.8±10.12-46.7±8.8, TDS 48.3±17.5-37.4±14.8, TSS 104.7±10.7-85.8±76.4, 36.6±4.7-29.6±24.9. Table 2 shows the heavy metals concentration of the wastewater. The mean concentrations of heavy metals in the untreated wastewater were Zn 7.84 mg/l, Pb 0.0100 mg/l, Cr 0.6065 mg/l and Cd 0.0075 mg/l. After treatment, mean values of Zn ranged from 0.358 - 0.628 mg/ml, Pb 0.00025 -0.001mg/l, Cr 0.0075 - 0.0175mg/l and Cd 0.00025-0.0018 mg/l. Table 3 shows microbial load before and after treatment with bio-coagulants and alum. Initial THBC after treatment with bio-coagulants ranged from 4.7 x $10^3$ - 5.3 x $10^2$ CFU/ml, TCC from 4.2 x $10^2$ – 6.7 x 10 CFU/ml and TFC from 1.1 x $10^2$ - 1.5 x 10 CFU/ml. On day 6, THBC ranged from 8-10 CFU/ml, TCC from 6 5-7 CFU/ml and TFC to 2-4 CFU/ml.

**Table 1: Mean physicochemical parameters of wastewater before and after treatment with bio-coagulants and alum**

| Parameters | Before treatment | *M. oleifera* | | | Snail shell | | | *M. oleifera* and snail shell | | | Alum | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5g | 15g | 25g | 5g | 15g | 25g | 5g | 15g | 25g | 5g | 15g | 25g |
| E.C. (μs.$cm^{-1}$) | 1227.7±311.5 | 210.0±108 | 214.0±100 | 196.5±67 | 199.1±69.87 | 214.5±69.9 | 196.2±53.2 | 194.7±10.7 | 198.9±103.6 | 194.5±60.2 | 269.7±90.3 | 257.0±91.9 | 244.1±89.9 |
| TOC (%) | 224.4±118.3 | 81.0±23 | 81.5±21 | 26.3±2,3 | 91.2±12.95 | 87.2±21.7 | 83.0±22.4 | 75.6±23.8 | 78.2±23.7 | 72.3±24.3 | 82.2±26.6 | 86.6±29.2 | 82.3±24.1 |
| BOD (mg/l) | 362.3±49.5 | 32.4±3.1 | 30.9±4.5 | 26.3±2.4 | 33.5±3.71 | 31.3±4.2 | 23.7±2.5 | 30.6±4.0 | 31.2±1.8 | 22.9±2.8 | 33.9±13.7 | 31.9±11.1 | 29.0±12.4 |
| COD (mg/l) | 1001.5±204.7 | 52.7±10.3 | 51.8±14.7 | 49.9±7.4 | 55.8±10.12 | 53.2±13.5 | 49.6±7.4 | 50.7±11.5 | 50.8±14.7 | 46.7±8.8 | 53.5±5.6 | 56.0±7.4 | 50.6±4.3 |
| TDS (mg/l) | 462.5±35.1 | 41.6±13.9 | 45.7±19.3 | 42.0±14.8 | 46.9±16.32 | 48.3±17.5 | 43.2±14.0 | 37.4±14.8 | 39.7±16.6 | 37.5±13.2 | 45.6±10.2 | 43.9±10.7 | 44.7±8.1 |
| TSS (mg/l) | 1562.5±198 | 99.8±3.9 | 99.4±23.8 | 89.2±29.3 | 104.3±91.5 | 104.7±10.7 | 92.9±84.9 | 95.2±8.9 | 92.5±86.6 | 85.8±76.4 | 125.9±36.94 | 98.0±82.3 | 96.7±83.8 |
| Turbidity (NTU) | 190.6±67 | 33.0±27.8 | 33.3±27.4 | 32.1±26.6 | 35.2±28.4 | 34.8±8.1 | 32.6±26.1 | 36.6±4.7 | 32.4±26.3 | 29.6±24.9 | 27.9±23.0 | 28.3±22.2 | 27.7±22.7 |

Keys: E.C.- Electrical conductivity, TOC- Total organic carbon, BOD- Biochemical oxygen demand, COD- Chemical oxygen demand, TDS- Total dissolved solids, TSS- Total suspended solids, NTU-Nephelometric Turbidity unit

*Scientia Africana, Vol. 22 (No. 2), August, 2023. Pp 287-296*
*© Faculty of Science, University of Port Harcourt, Printed in Nigeria* *ISSN 1118 – 1931*

**Table 2: Heavy metals in abattoir wastewater before and after treatment**

| Treatment type | Parameters | Zn (mg/l) | Pb (mg/l) | Cr (mg/l) | Cd (mg/l) |
|---|---|---|---|---|---|
| | Before treatment | 7.84±2.5 | 0.0100±0.014 | 0.6065±0.99 | 0.0075±0.005 |
| *M. oleifera* | 5g | 0.47±0.07 | 0.001±0.001 | 0.0125±0.01 | 0.0008±0.001 |
| | 15g | 0.56±0.09 | 0.001±0.001 | 0.0125±0.01 | 0.0008±0.001 |
| | 25g | 0.44±0.04 | 0.0003±0.001 | 0.0125±0.01 | 0.0018±0.002 |
| Snail shell | 5g | 0.615±0.180 | 0.001±0.001 | 0.0175±0.021 | 0.0008±0.001 |
| | 15g | 0.628±0.115 | 0.0003±0.001 | 0.0175±0.0122 | 0.0008±0.001 |
| | 25g | 0.468±0.114 | 0.0003±0.001 | 0.0175±0.022 | 0.0008±0.001 |
| *M. oleifera* and snail shell | 5g | 0.363±0.160 | 0.00025±0.001 | 0.0168±0.022 | 0.001±0.001 |
| | 15g | 0.388±0.103 | 0.00025±0.001 | 0.017±0.022 | 0.001±0.001 |
| | 25g | 0.358±0.148 | 0.0003±0.001 | 0.0075±0.01 | 0.00025±0.01 |

Keys: Zn- Zinc, Pb- Lead, Cr- Chromium, Cd- Cadmium

**Table 3: Microbial load in abattoir wastewater before and after treatment with 25g bio-coagulant and alum**

| Treatment type | Parameters | THBC (CFU/ml) | TCC (CFU/ml) | TFC (CFU/ml) |
|---|---|---|---|---|
| | Before treatment | $1.4 \times 10^8$ | $5.6 \times 10^5$ | $1.6 \times 10^2$ |
| *M. oleifera* seed | Initial | $3.0 \times 10^3$ | $2.7 \times 10^2$ | 6.0 x 10 |
| | Day-3 | 7.7 x 10 | 1.3 x 10 | 8.0 |
| | Day-6 | 8.0 | 5.0 | 2.0 |
| Snail shell | Initial | $4.7 \times 10^3$ | $4.2 \times 10^2$ | $1.1 \times 10^2$ |
| | Day-3 | $6.3 \times 10^2$ | $2.7 \times 10^2$ | 3.2 x 10 |
| | Day-6 | 1.8 x 10 | 2.4 x 10 | 5.0 |
| *M. oleifera* and snail shell | Initial | $5.3 \times 10^2$ | 6.7 x 10 | 1.5 x 10 |
| | Day-3 | 1.6 x 10 | 8.0 | 4.0 |
| | Day-6 | 10.0 | 7.0 | 4.0 |
| Alum | Initial | $7.1 \times 10^2$ | 9.4 x 10 | 2.3 x 10 |
| | Day-3 | 1.1 x 10 | 4.0 | 3.0 |
| | Day-6 | 4.0 | 4.0 | 3.0 |

Keys: THBC- Total heterotrophic bacterial count, TCC- Total Coliform Count, TFC-Total Fungal Count, CFU- Colony Forming Unit, ml- Millilitres

Table 4 shows the effect of treated and untreated abattoir wastewater on waterleaf plants. The growth parameters vary between treated and untreated abattoir wastewater.

**Table 4: Effect of treated and untreated abattoir wastewater on plant growth**

| **Parameter** | **Untreated water** | **Distilled water** | **Treated water** |
|---|---|---|---|
| Leaf height (cm) | $4.0 \pm 0.03^a$ | $5.6 \pm 0.10^b$ | $5.2 \pm 0.07^b$ |
| Leaf breadth (cm) | $1.2 \pm 0.01^a$ | $2.9 \pm 0.02^b$ | $2.5 \pm 0.03^b$ |
| Area of leaf (($cm^2$) | $4.8 \pm 0.21^a$ | $16.24 \pm 0.05^b$ | $13 \pm 0.01^b$ |
| Shoot height (cm) | $3.4 \pm 0.05^a$ | $4.7 \pm 0.11^b$ | $4.3 \pm 0.16^b$ |
| Root length (cm) | $3.2 \pm 0.22^a$ | $4.5 \pm 0.03^b$ | $4.1 \pm 0.04^b$ |
| Weight (g) | $23 \pm 0.01^a$ | $33 \pm 0.24^b$ | $28 \pm 0.01^b$ |

Keys: a- Not significant ($p > 0.05$), b- Significant at p value $< 0.05$.

## DISCUSSION

The present study evaluated the suitability of using cheap bio-coagulants for treating abattoir wastewater, which is oftentimes discharged directly into soil and water bodies without treatment. A key process involved in wastewater treatment for the removal of dissolved and suspended waste that can impact water quality involves the use of synthetic coagulants, primarily alum.

In this study, we looked at the effect of using three different masses of coagulants (5g, 15g and 25g) and assessed the physicochemical and microbiological parameters afterwards. The results obtained revealed that for almost all parameters monitored 25g of coagulants yielded the best results in terms of reduction in monitored parameters. Percentage reduction in physicochemical parameters with *M. oleifera* treatment are as follows: EC 82-89%, TOC 50-74%, BOD 92-93%, COD 94-96%, TDS 81-93%, TSS 78-99%, and turbidity 78-88%. Similar percentages were reported in a previous study by Shittu et al. (2006) and Okonko & Shittu (2007) in Ogun State, Nigeria.

Treatment with snail shell brought about a 79-88% reduction in EC, TOC 54-74%, BOD 92-94%, COD 94-96%, TDS 81-93%, TSS 78-99%, and turbidity 79-87%. Similarly, treatment with *M. oleifera* and snail shell brought about a reduction in EC (82-87 %), TOC (55-76%), BOD (90-95%), COD (95-96%), TDS (80-94%), TSS (73-99%), and turbidity (80-89%). While the result for treatment with alum brought a reduction in EC (77-85%), TOC (46-76%), BOD (88-94%), COD (94-96%), TDS (86-93%), TSS (77-99%) and turbidity (81-89%).

Overall, the bio-coagulants caused 82.5-84.2% reduction in EC, TOC 59-88.3%, BOD 90.8-93.7%, COD 94.4-95.3%, TDS 89.6-91.9%, TSS 93.3-94.5% and 80.8-84.5% reduction in turbidity. The bio-coagulants were able to remove 92.2-95.4% of Zn, 97-97.5% of Pb, 97.2-98.8% of Cr, and 86.7-89.3% of Cd. No statistically significant difference was found with the different treatments, as compared with the chemical coagulant (alum). The coagulant properties of the *M. oleifera* seed and snail shell could be attributed to the presence of cationic proteins with strong coagulation properties, that enable the removal of particulate matter, colloidal substances that make water turbid and other pollutants from wastewater, as suggested by Okey-Onyesolu et al. (2020).

There is a plethora of reports supporting the use of bio-coagulants for the treatment of wastewater in agreement with the present study. Nwabanne and Obi (2019) reported the coagulation-flocculation performance of snail shell biomass in abattoir wastewater treatment, including a reduction in turbidity, TDS and TSS. Okey-Onyesolu et al. (2020) reported a reduction in turbidity, COD and BOD with the use of chitin protein as a bio-coagulants. Nhung et al. (2023) reported that snail shells have high calcium content (>99%) and a large potential surface area which makes them suitable as an adsorbent. Egbuikwem and Sangodoyin (2013) investigated the efficiency of *M. oleifera* seeds as a coagulant for water treatment. These researchers found that extracts from the seeds effectively reduced turbidity and removed suspended particles from water samples. Just like in the present study, the extract was found to be as effective as synthetic coagulants such as aluminium sulfate (alum). Mohan et al. (2016) likewise reported that *M. oleifera* powder effectively reduced turbidity and electrical conductivity in abattoir wastewater, indicating its potential as a natural coagulant for wastewater treatment. Similarly, Shittu et al. (2006) reported that *M.*

*Scientia Africana, Vol. 22 (No. 2), August, 2023. Pp 287-296*
*© Faculty of Science, University of Port Harcourt, Printed in Nigeria* *ISSN 1118 – 1931*

*oleifera* powder effectively reduced turbidity in Ogun State, Nigeria.

After treatment with the bio-coagulants, THBC of the wastewater dropped from 4.7 x $10^3$ - 5.3 x $10^2$ CFU/ml to 8-10 CFU/ml on day 6, TCC dropped from 4.2 x $10^2$ – 6.7 x 10 CFU/ml to 5-7 CFU/ml on day 6 while TFC dropped from 1.1 x $10^2$ - 1.5 x 10 CFU/ml to 2-4 CFU/ml on day 6, representing approximately 99.9% reduction in microbial load. The antimicrobial properties of *M. oleifera*, snail shell and alum have been reported (Shittu et al., 2006; Okonko & Shittu, 2007; Shahiriari et al., 2017, Bancessi et al., 2020; Okoh et al., 2020).

In the present study, it was revealed that the coagulants caused a reduction in THBC, TFC and TCC. This is contrary to Nisar & Koul [2021] that posit that water treated with bio-coagulants might result in a secondary increase of bacteria population after coagulation. A possible reason for the contradictory result from the two studies is that the coagulant was not filtered after use. This is because the bio-coagulants are known to be rich in nutrients capable of supporting microbial growth.

The untreated abattoir wastewater used to water potted plants led to blight and wilting of plant leaves, indicative of its toxicity to plant growth. Upon irrigation of plants with treated abattoir wastewater, the plant grew luxuriantly as indicated by their leave areas, shoot and root height. The growth parameters of the plants vary between treated and untreated abattoir wastewater. These differences were significant ($p<0.05$). There was no significant difference ($p>0.05$) between plants irrigated with treated abattoir wastewater and distilled water. According to Jeong et al. (2016), treated effluents could be used for agricultural purposes which include irrigation of farmlands, so long as they comply with discharge standards.

## CONCLUSION

Moringa seed and snail shells bio-coagulants were efficient in the treatment of abattoir wastewater as they were able to cause significant reduction in EC, TOC, BOD, COD, TDS, TSS, and turbidity, comparable to the chemical coagulant (alum). Therefore, the use of moringa seed and snail shell should be promoted for the treatment of wastewater from abattoirs before it is discharged into waterbodies.

## REFERENCES

Abubakar GA, Tukur A. Impact of abattoir effluent on soil chemical properties in Yola, Adamawa State, Nigeria. *International Journal of Sustainable Agricultural Research*. 2014; 1(4): 100-107.

Adeniran KA, Akpenpuun TD, Akinyemi BA, Wasiu RA. Effectiveness of *Moringa oleifera* seed as a coagulant in domestic wastewater treatment. *African Journal of Science, Technology Innovation and Development*. 2017; 9(4): 1-6.

Adzittey F, Teye GA, Ayim, AG, Addy S. Microbial quality of chevon and mutton sold in Tamale metropolis of Northern Ghana. *Journal of Applied Science Environmental Management*. 2010; 14(4): 53-55.

Ali EN, Muyibi SA, Salleh HM, Alam MD, Salleh MRM. Production of natural coagulant from Moringa oleifera seed for application in treatment of low turbidity water. *J. Water Resource and Protection*. 2010; 2: 259-266.

Aneja KR. Experiments in microbiology, plant pathology and biotechnology. 2013.

Aniebo A, Wekhe SN, Okoli IC. Abattoir blood waste generation in Rivers State and its environmental implications in the Niger Delta. *Toxicological and Environmental Chemistry*. 2009; 91: 619-625.

APHA. Standard methods for the examination of water and wastewater. American Public Health Association, Washington, DC. 2005.

Bancessi A, Pinto MMF, Duarte E, Catarino L, Nazareth T. The antimicrobial properties of Moringa oleifera Lam. for water treatment: a systematic review. *SN Applied Sciences*. 2020; 2:323. https://doi.org/10.1007/s42452-020-2142-4

Egbuikwem PN, Sangodoyin AY. Coagulation efficacy of moringa oleifera seed extract compared to alum for removal of turbidity and *E. coli* in three different water sources. *European International Journal of Science and Technology*, 2013; 2: 13-20.

Ibiene, A.A., Ekwuribe, N.C., Osadebe,A. U., & Okerentugba, P.O. (2021). Nutritional, Functional and Microbiological Analysis of Powdered Seed of *Moringa oleifera*. *International Journal of Biochemistry and Biophysics*, 9(1), 1 - 7.

Jeong, H, Kim H, Jang T, Park S. Assessing the effects of indirect wastewater reuse on paddy irrigation in the Osan River watershed in Korea using the SWAT model. *Agricultural Water Management*, 2016; 163(1): 393-402.

Maduabuchi MN. Bacteriological treatment of wastewater from paint industry using *Moringa oleifera* seed. *International Journal of Waste Resources*, 2018; 8(2):1-4.

Mohammed S, Musa JJ. Impact of abattoir effluent on river landzu. Bida, Nigeria. *Journal of Chemical Biological and Physical Science*, 2012; 2(1):132-136.

Mohan C, Vidyavathi N, Ramalinga RY. Bio-coagulation of chicken abattoir wastewater using *Moringa oleifera* leaves. International Journal of Development Research. 2016; 06(5): 7863-7866.

Neboh HA, Ilusanya OA, Ezekoye CC, Orji FA Assessment of Ijebu-Igbo Abattoir effluent and its impact on the ecology of the receiving soil and river. IOSR Journal Of Environmental Science, Toxicology And Food Technology. 2013; 7(5): 61-67.

Nhung NTH, Long VD, Fujita T. A Critical Review of Snail Shell Material Modification for Applications in Wastewater Treatment. Materials. 2023; 16: 1095. https://doi.org/10.3390/ma16031095

Nisar N, Koul B. Application of Moringa oleifera lam. seeds in wastewater treatment. Plant Archive. 2021; 21(1): 2408-2417.

Nwabanne JT, Obi CC. Coagulation-flocculation performance of snail shell biomass in abattoir wastewater treatment. Journal of Chemical Technology and Metallurgy. 2019; 54(6): 1177-1188.

Nwachukwu MI, Akinde SB, Udujih OS, Nwachukwu IO. Effect of Abattoir wastes on the population of proteolytic and lipolytic bacteria in a recipient water body (Otamiri River). Global Resource Journal of Science. 2011; 1: 40-42.

Ogbomida ET, Kubeyinje B, Ezemonye LI. Evaluation of bacterial profile and biodegradation potential of abattoir wastewater. African Journal of Environmental Science and Technology. 2016; 10(2): 50-57.

Okey-Onyesolu CF, Chukwuma E, Okoye C, Onukwuli O. Response surface

*Scientia Africana, Vol. 22 (No. 2), August, 2023. Pp 287-296*
*© Faculty of Science, University of Port Harcourt, Printed in Nigeria* *ISSN 1118 – 1931*

methodology optimization of Chito-protein synthesized from crab shell in treatment of abattoir wastewater. Heliyon. 2020; 6 (10): e05186.

Okoh PD, Paul JN, Ofoeyeno ET. Effect of powdered Achantina fulica species snail shell on wound morphometry of Wistar rats. Saudi J Med. 2020; 5(3): 153-158

Okonko IO, Shittu OB. 2007. Bioremediation of wastewater and municipal water treatment using latex exudate from *Calotropis procera* (Sodom apple). *EJEAFChe 6 (3):1890-1904*

Prescott LM, Harley J., Klein DA. Microbiology. 6th Ed., McGraw Hill, London. 2005.

Shahriari R, Salari S, Shahriari S. In vitro study of concentration-effect and time-course pattern of white alum on Escherichia coli O157:h7 growth. Afr J Tradit Complement Altern Med. 2017; 14(2): 311–318.

Shittu OB, Akpan I, Okonko IO. 2006. Comparative coagulant properties of latex of *Calotropis procera* and ground seeds of *Moringa oleifera. Nigerian Journal of Microbiology, 30: 1419-1426*

Stanley HO, Odu NN, Ekoh PE. Microbiological and Physicochemical assessment of wastewater from selected food industry in Port Harcourt and snail shell treatment potentials. Biomedicines and Nursing. 2020; 6(1): 74-79.

Sumayya BU, Usman BU, Aisha U, Shahida A, Mohammad A, Yakubu MS, Zainab, M. Determination of physiochemical qualities of abattoir effluent on soil and water in Gandu, Sokoto State. Journal of Environmental Science, Toxicology and Food Technology. 2013; 4(4): 47-50.

Tamenech B, Tamirat H. Review on abattoir waste management. Global Veterinaria. 2017; 19(2): 517-524.