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Effects Of Fish Pond Wastewater Treated with Bio-Coagulants on The Growth Performance of African Catfish (*Clarias Gariepinus*)

By

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Abstract

This study was carried out to determine the effects of fishpond wastewater treated with bio-coagulants on the growth performance of African catfish (Clarias gariepinus). Matured and naturally dry seeds of Moringa oleifera (brown in colour) was harvested from a healthy Moringa tree in a botanical garden of Federal University of Technology, Owerri. While the shells of African giant snail shells (Achatina achatina) was bought from Akachukwu restaurant Ihiagwa. Seven (7) different ponds of 100 liters capacity made from concrete was prepared in school of agriculture and agricultural technology farm Federal University of Technology, Owerri. Sixty litres of wastewater from the different ponds individually was collected into two different 100 litres plastic butter and labeled according with the different Bio-coagulants used in the treatment process. All analysis was determined at significant level of P>0.05. The results further revealed that the highest mean values of colour (8 ± 2.0) after treatment with snail shell powder coagulant and Moringa oleifera seed powder coagulant (6 ± 1.0) while the least value was obtained before bio-coagulant application. Results obtained showed the presence or presence of bioactive compounds such as Alkaloids, Flavonoids, Saponins, Cardiac glucosides (%) and Anthraquinone (mg/100g) in the plant extracts. Cardiac glucosides yielded the highest phytoconstituents with a mean value of 44.44 ± 5.31 (%) while the least value was gotten from Terpenoids with a mean value of 1.13 ± 0.07. Among the mineral composition, calcium recorded the highest mean concentration (14177.58 ± 111.17 mg/100g) followed by phosphorus (202.04 ± 28.95 mg/100g) while the least mineral recorded from the snail shell powder was manganese (0.17 ± 0.02 mg/100g). The results revealed that there was a significant difference (p>0.05) in mean length of catfish treated with Snail shell powder (300g) and Moringa Oleifera seed powder relative to the control. Increase in mean length of catfish was observed to correspondingly increase as the week of bio-coagulants treatments increases. From the research, results of snail shell materials had higher treatment potentials than M. oleifera powder; it is shown that modification will be a good research direction to increase the adsorption capacity by increasing the surface of the shell material.

Keywords: *fish pond, wastewater, bio-coagulants, growth performance, African catfish*

Introduction

Bio-coagulants are natural substances derived from plant materials or microbial sources that possess coagulation and flocculation properties. They have gained significant attention in recent years as eco-friendly alternatives to conventional chemical coagulants in water treatment processes. The application of bio-coagulants in fish ponds aims to improve water quality parameters such as turbidity, suspended solids, and organic matter content, ultimately influencing fish growth performance.

The growth performance of fish species, including African catfish, is influenced by several environmental factors, with water quality being a critical determinant. Poor water quality, characterized by high turbidity, suspended solids, and excessive organic matter, can adversely affect fish health and growth. These conditions can lead to reduced dissolved oxygen levels, increased bacterial load, and limited availability of essential nutrients, all of which hamper the fish's overall performance (Kim *et al.*, 2020).

By employing bio-coagulants, fish farmers can potentially mitigate these challenges and optimize fish pond conditions. Bio-coagulants work by promoting the aggregation of suspended particles, algae, and other organic matter present in the water column (Dar, Yousuf, & Balkhi, 2018). This aggregation results in the formation of larger, easily removable particles, thus reducing turbidity and improving water clarity. Furthermore, the use of bio-coagulants helps to enhance water filtration processes, leading to the removal of harmful substances and providing better overall water quality

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for fish (Mahboob & Sheri, 2018). Improved water quality resulting from bio-coagulant application has been associated with enhanced fish health, reduced stress levels, improved feed utilization, and ultimately, increased growth rates and biomass production. Additionally, bio-coagulants have demonstrated their ability to reduce disease outbreaks, as they help create an environment that is less favorable for pathogenic microorganisms to thrive (Copat, Bella, Castaing, Fallico, Sciacca, & Ferrante, 2020).

However, in Nigeria, government established various environmental protection and regulatory agencies in an attempt to provide a pollution-free environment, but in spite of these efforts, the pollution problem remains unabated. Natural coagulants have been investigated with immense potential in water treatment applications (Ang & Mohammad 2020). The water treatment process removes suspended and colloidal materials and particles in water, such as organic matter, microbes, and inorganic matter (Jayalakshmi *et al*., 2017). Various plant-based materials have been used in many parts of the world, such as China, India, and even Africa (Asrafuzzaman, Fakhruddin, & Hossain, 2011). Due to the health, costs, and environmental aspects of many inorganic and synthetic coagulants, numerous studies have recently been conducted to search for a sustainable, eco-friendly, and non-toxic alternative to inorganic coagulants for water treatment purposes. The use of plant-based coagulants for water treatment has gained more interest as a natural, cost effective, and renewable method that has been widely studied in the past few decades.

Materials and methods

The Study Area

The study was carried out in Imo state Nigeria, lying within latitude 40451N and 70151 N and longitude 60501 E and 70251 E. It has a total area of 5,100 square kilometres and a population of 4.8 million persons. The capital city is Owerri. Imo has three geopolitical zones namely; Owerri, Orlu, and Okigwe and twenty-nine local government areas. There are two distinct seasons within this area, namely; rainy seasons, which begins in the month of April and lasts until October, with annual rainfall varying from 1,500-2,200mm (60-80 inches), while the dry seasons is ushered in by harmattan period and are characterized by hot weather and low humidity. The rainy season is associated with very high humidity of about 80-85% with very heavy rainfall. Temperature varies according to season between 25^0c to 32^0c in sunny days. The forest/vegetation in Owerri is a rain forest with lots of plants diversity, growing under the described climatic conditions. The population is predominantly Igbos and Christians.

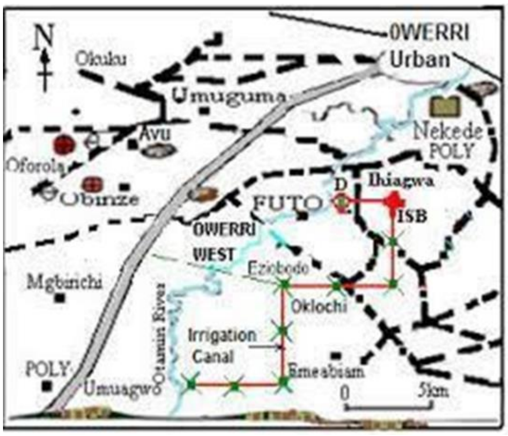

Figure 3.1: Map of the study area.

Sample collection and authentication

***Moringa oleifera* seed sample**

Matured and naturally dry seeds of Moringa oleifera (brown in colour) was harvested from a healthy Moringa tree in a botanical garden of Federal University of Technology, Owerri. While the shells of African giant snail shells (Achatina achatina) was bought from Akachukwu restaurant Ihiagwa. The samples was identified and authenticated by Dr. C. M. Duru, plant biosystematist Biology Department, Federal University of Technology Owerri.

African giant (*Achatina achatina*) snail shell

African giant snail shells (Achatina achatina) was collected from Akachukwu restaurant Ihiagwa. The snail shells was identified and authenticated by Dr. C. M. Duru, Department of Biology, Federal University of Technology, Owerri. The samples were thoroughly cleaned to remove any dirt or organic matter. The shells was properly dried under controlled conditions to eliminate moisture content. Once dried, they were crushed into a fine powder using a mechanical grinder. The resulting snail shell powder was sieved to achieve a consistent particle size for subsequent experiments.

Fingerlings of African Catfish

Healthy and active fingerlings of pure stock of *C. gariepinus* was bought from Livestock specialist farm, Wetheral Owerri, Imo state Nigeria. They were transported to school of agriculture and agricultural technology, Federal university of Technology, Owerri.

Preparation of Samples

Preparation of Seeds of *Moringa oleifera*

The methodology of Dehghani & Alizadeh, (2016) with slight modification was used. The seeds of Moringa oleifera was dehusked manually using kitchen knife and then, dried in an oven at 350C for 5 hours to make sure they are properly dried before triturating into fine powder with home blender and then, stored in an airtight plastic container for further use.

Preparation of snail shell powder

The methodology of Siti, Dine, Monica, & Hafid, (2022) with slight modification was used. The samples from African snail shell were thoroughly washed to remove any dirt or organic matter, after which they was allowed to dry properly under

*Corresponding Author: **Nwamba, I.M.**

controlled conditions to eliminate moisture content. Once dried, they were crushed into a fine powder using a mechanical grinder. The resulting snail shell powder was sieved to achieve a consistent particle size and stored in a plastic bottle for subsequent uses.

Pond Preparation and Stocking of Fingerlings of *C. gariepinus*

Seven (7) different ponds of 100 liters capacity made from concrete was prepared in school of agriculture and agricultural technology farm Federal University of Technology, Owerri. The ponds was washed thoroughly with normal saline solution before adding 75 litres of clean and fresh tap water. The pH, temperature and turbidity was accessed and recorded before adding the fingerlings. Fifty (50) fingerlings of *C. gariepinus* with extra five (5) each, making it a total of 55 fingerlings was introduced differently into the ponds and allow to acclimatize for 2 days, before feeding.

Treatment of Fish Pond Wastewater with the different Bio-coagulants.

Sixty litres of wastewater from the different ponds individually was collected into two different 100 litres plastic butter and labeled according with the different Bio-coagulants used in the treatment process. 50 grams of the pulverized shell powder of African giant snail and *M. oleifera* seed powder was weighed and add different to the two different butter. The resulting mixtures was agitated for 5 minutes before allowing to stand undisturbed for 1 hours. The treated wastewater was subjected to pH, temperature and turbidity test before adding back into the ponds and label the ponds according to the different treatment. This process was replicated into three (3) different replicate for better result. The control pond was prepared also and no treatment was used.

Determination of weight, length and mortality of the fish

The methodology of Akinwole, Dauda, & Ololade, (2016). The initial weight of the fingerlings in each pond was weighed with an electronic weighing balance and the length measured with ruler and recorded before adding to the pond. Subsequent weight and length was determined continuous before each treatment. In addition, the number of mortality was checked against each pond and recorded. The prices will continue until the fish gets to maturity.

3.7 Statistical Data Analysis

The data generated from the study was analyzed using tables, charts, Analysis of Variance (ANOVA). All analysis was determined at significant level of P>0.05.

RESULTS AND DISCUSSION

RESULTS

Table 1: Physico-chemical parameters of pond water samples before and after bio-coagulants

The result of Physico-chemical parameters of pond water samples before and after bio-coagulants along with the WHO standard for drinking water is shown in Table 4.1. The results revealed a significant difference (p<0.05) in the Appearance, Colour, Odour, Turbidity, Temperature, Dissolved Oxygen, Biological Oxygen Demand Sulphate and total suspended solids before and after treatment with shell powder coagulant and *Moringa oleifera* seed powder coagulant. The pond water samples was not clear as against the WHO standard. The results further revealed that the highest mean values of colour (8 ± 2.0) after treatment with snail shell powder coagulant and *Moringa oleifera* seed powder coagulant (6 ± 1.0) while the least value was obtained before bio-coagulant application.

The pond water samples were observed to be unobjectionable with taste before and after treatments with bio-coagulants. Turbidity, NTU was recorded to be high before treatment application with a mean value of 6.34 ± 0.42 while the least value of Turbidity was gotten after treatment with snail shell powder coagulant (5.03 ± 0.27). However, the value for turbidity was below WHO standard. There was no significant difference in Temperature after treatment with snail shell powder coagulant and *Moringa oleifera* seed powder coagulant . However, the highest mean value of Temperature was obtained before biocoagulant application (6.34 ± 0.42) while the least was gotten after treatment with snail shell powder and *Moringa oleifera* seed powder coagulant (27± 2.03). There was no significant difference in Electrical conductivity and Hardness before and after treatment application. TDS varied significantly with the highest mean value obtained before treatments (27.59 ± 3.45) and reduced after treatment with snail shell powder coagulant (11.74 ± 1.78) and *Moringa oleifera* seed powder coagulant 17.21 ± 2.24 There was no significant difference (p<0.05) in DO, BOD, Sulphate, Nitrate and TSS before and after treatment application.

Table 1: Physico-chemical parameters of pond water samples before and after bio-coagulants

S/N	PARAMETERS	WHO'S STD	SAMPLES		
			Before bio-coagulant	After snail shell powder coagulant	After *Moringa oleifera* seed powder coagulant
1	Appearance	clear	Not clear	Not clear	Not clear
2.	Colour, Pt Co	15	4 ± 1.0	8 ± 2.0	6 ± 1.0
3.	Odour	Odourless	unobjectionable	Unobjectionable	Unobjectionable
4.	Taste	Tasteless	Taste	Taste	Taste

*Corresponding Author: **Nwamba, I.M.**

5.	Turbidity, NTU	50	6.34 ± 0.42	5.03 ± 0.27	5.18 ± 0.31
6.	Temperature, ^{0}C	-	28 ± 2.04	27± 2.03	27 ± 2.03
7.	pH	6.5-8.5	6.47 ± 1.06	6.55 ± 1.08	6.58 ± 1.11
8.	Electrical conductivity, µS/CM	100	0.35 ± 0.07	0.35 ± 0.07	0.35 ± 0.07
9.	Hardness, Mg/L	250	75.45 ± 4.32	70.11 ± 3.11	72.43 ± 3.02
10.	TDS, Mg/L	250	27.59 ± 3.45	11.74 ± 1.78	17.21 ± 2.24
11.	DO, Mg/L	6.0	4.18 ± 0.62	5.48 ± 0.83	5.30 ± 0.79
12.	BOD, Mg/L	4.0	3.56 ± 0.17	3.78 ± 0.23	3.77 ± 0.20
13.	Sulphate, Mg/L	250	3.87 ± 0.15	2.65 ± 0.13	2.09 ± 0.09
14	Nitrate, Mg/L	40	2.33 ± 0.12	4.03 ± 0.23	2.25 ± 0.10
15	TSS	50	26.9 ± 3.32	11.8 ± 1.08	17.6 ± 2.12

Samples in triplicates, TDS = Total dissolved solids, DO = Dissolved oxygen, BOD = Biochemical oxygen demand, TSS = Total suspended solids.

Qualitative and Quantitative phytochemical properties of *Moringa oleifera*

Mean concentrations of the qualitative phytochemical constituents of the plant extracts *Moringa oleifera* seed powder used for the study is presented Table 2. Results obtained showed the presence or presence of bioactive compounds such as Alkaloids, Flavonoids, Saponins, Cardiac glucosides (%) and Anthraquinone (mg/100g) in the plant extracts. Cardiac glucosides yielded the highest phytoconstituents with a mean value of 44.44 ± 5.31 (%) while the least value was gotten from Terpenoids with a mean value of 1.13 ± 0.07.

Table 2: Qualitative and quantitative photochemical results of *Moringa oleifera* seed powder

Parameters	Qualitative	Quantitative
Alkaloids	+	13.21 ± 2.42
Saponins	+	2.39 ± 0.53
Tannins	-	-
Terpenoids	+	1.13 ± 0.07
Steroids	-	-
Anthraquinones	-	-
Cardiac glucosides	+	44.44 ± 5.31
Flavonoid	+	13.50 ± 2.93

Samples in triplicates

Mineral composition in snail shell powder

Results of the mineral composition of the snail shell powder used for the study is shown in Table 3. The results showed that snail shell powder containe minerals such as sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), phosphorus (P), iron (Fe) and manganese (Mn). Among the mineral composition, calcium recorded the highest mean concentration (14177.58 ± 111.17 mg/100g) followed by phosphorus (202.04 ± 28.95 mg/100g) while the least mineral recorded from the snail shell powder was manganese (0.17 ± 0.02 mg/100g).

Table 3: Mineral composition in snail shell powder

Mineral elements	Concentration (mg/100g)
Na	6.98 ± 0.83
K	23.45 ± 3.01
Ca	14177.58 ± 111.17
Mg	67.09 ± 7.64
P	202.04 ± 28.95
Fe	2.35 ± 0.42
Mn	0.17 ± 0.02

Samples in triplicates

Mean Length of catfish measured from untreated pond water and treated pond water with bio-coagulants

Mean Length of catfish measured from untreated pond water and treated pond water with Snail shell powder (300g) and *Moringa Oleifera* seed powder (300g) is presented in Table 4.4. The results revealed that there was a significant difference ($p>0.05$) in mean length of catfish treated with Snail shell powder (300g) and *Moringa Oleifera* seed powder relative to the control. Increase in mean length of catfish was observed to correspondingly increase as the week of bio-coagulants treatments increases. The highest mean length of catfish samples treated with Snail shell powder (300g) was recorded at 16 weeks after bio-coagulants (81.22 ± 4.28) when compared with the control with a mean value of 71.23 ± 4.19 while the least mean length was recorded at two (2) WAB. *Moringa Oleifera* seed powder (300g) at 16 WAB recorded

*Corresponding Author: **Nwamba, I.M.**

the highest mean catfish length (77.12 ± 4.21) while the least was recorded from two (2) WAB (31.14± 2.24). However, mean values of length of catfish species were significantly (P<0.05) higher on treatment with Snail shell powder (300g) than *Moringa Oleifera* seed powder (300g).

Table 4.4: Mean Length of catfish measured from untreated pond water and treated pond water with bio-coagulants

Treatments	Number measured	Weeks after bio-coagulants (WAB)							
		Number and mean length of catfish measured (cm)							
		2 WAB	4 WAB	6 WAB	8 WAB	10 WAB	12 WAB	14 WAB	16 WAB
Control (0g)	12	24.18 ± 2.13^c	27.61 ± 2.15^c	29.42 ± 2.17^c	34.12 ± 2.20^c	41.21 ± 3.12^c	52.32 ± 3.17^a	63.11 ± 4.14^c	71.23 ± 4.19^c
Snail shell powder (300g)	12	38.44 ± 3.21^a	40.25 ± 3.25^a	43.23 ± 3.25^a	47.18 ± 3.28^a	49.39 ± 3.31^a	59.53 ± 4.03^b	69.31 ± 4.21^a	81.22 ± 4.28^a
Moringa Oleifera seed powder (300g)	12	31.14± 2.24^b	37.81 ± 2.26^b	39.27 ± 2.29^b	42.18 ± 2.78^b	45.33 ± 3.27^b	55.45 ± 3.22^b	67.13 ± 4.18^b	77.12 ± 4.21^b

Mean along the column having different superscript of alphabets differ significantly at P ≤ 0.05 by least significant difference

Mean width of catfish measured from untreated pond water and treated pond water with bio-coagulants

Mean width of catfish measured from untreated pond water and treated pond water with Snail shell powder (300g) and *Moringa Oleifera* seed powder (300g) is presented in Table 4.5. The results revealed that there was a significant difference (p>0.05) in mean length of catfish treated with Snail shell powder (300g) and *Moringa Oleifera* seed powder relative to the control. Similarly, increase in mean width of catfish was observed to correspondingly increase as the week of bio-coagulants treatments increased. The highest mean width of catfish samples treated with Snail shell powder (300g) was recorded at 16 weeks after bio-coagulants (13.76 ± 1.44) when compared with the control with a mean value of 12.01 ± 1.11 while the least mean width was recorded at two (2) WAB. *Moringa Oleifera* seed powder (300g) at 16 WAB recorded the highest mean catfish length (77.12 ± 4.21) while the least was recorded from two (2) WAB (6.33 ± 1.18 cm). However, mean values of width of catfish species were significantly (P<0.05) higher on treatment with Snail shell powder (300g) than *Moringa Oleifera* seed powder (300g).

Table 4.5: Mean width of catfish measured from untreated pond water and treated pond water with bio-coagulants

Treatments	Number measured	Weeks after bio-coagulants (WAB)							
		Number mean width of catfish measured (cm)							
		2 WAB	4 WAB	6 WAB	8 WAB	10 WAB	12 WAB	14 WAB	16 WAB
Control (0g)	12	4.11 ± 1.01^c	5.17 ± 1.07^c	7.20 ± 1.10^c	8.11 ± 1.17^c	9.43 ± 1.21^c	10.31 ± 1.30^a	11.29 ± 1.07^a	12.01 ± 1.11^a
Snail shell powder (300g)	12	6.33 ± 1.18^a	7.35 ± 1.21^a	8.39 ± 1.25^a	9.31 ± 1.28^a	11.34 ± 1.31^a	13.26 ± 1.38^b	13.28 ± 1.39^b	13.76 ± 1.44^b
Moringa Oleifera seed powder (300g)	12	5.31± 1.12^b	6.34± 1.15^b	7.38± 1.18^b	9.01± 1.22^b	10.08± 1.26^b	11.12 ± 1.32^b	12.46 ± 1.37^b	12.58 ± 1.39^b

Mean along the column having different superscript of alphabets differ significantly at P ≤ 0.05 by least significant difference

Mean head circumference of catfish measured from untreated pond water and treated pond water with bio-coagulants Mean head circumference of catfish measured from untreated pond water and treated pond water with Snail shell powder (300g) and *Moringa Oleifera* seed powder (300g) is presented in Table 4.6. The results showed that there was a significant difference (p>0.05) in mean head circumference of catfish treated with Snail shell powder (300g) and *Moringa Oleifera* seed powder relative to the control. Accordingly, increase in mean head circumference of catfish was observed to correspondingly increase as the week of bio-coagulants treatments increased. The highest mean head circumference of catfish samples treated with Snail shell powder (300g) was recorded at

*Corresponding Author: **Nwamba, I.M.**

16 weeks after bio-coagulants (17.14 ± 1.31 cm) when compared with the control with a mean value of 15.22 ± 1.25 cm while the least mean head circumference was recorded at two (2) WAB (15.28 ± 1.09 cm). *Moringa Oleifera* seed powder (300g) at 16 WAB recorded the highest mean catfish head circumference (16.16 ± 1.29 cm) while the least was recorded from two (2) WAB (14.25 ± 1.04 cm). However, mean values of head circumference of catfish species were significantly (P<0.05) higher on treatment with Snail shell powder (300g) than *Moringa Oleifera* seed powder (300g).

Mean head circumference of catfish measured from untreated pond water and treated pond water with bio-coagulants

Treatments	Number measured	Weeks after bio-coagulants (WAB)							
		Number and mean head circumference of catfish measured (cm)							
		2 WAB	4 WAB	6 WAB	8 WAB	10 WAB	12 WAB	14 WAB	16 WAB
Control (0g)	12	12.14 ± 0.83[c]	12.17 ± 0.98[c]	12.19 ± 1.01[c]	13.11 ± 1.07[c]	13.15 ± 1.12[c]	14.27 ± 1.15[c]	15.03 ± 1.22[c]	15.22 ± 1.25[c]
Snail shell powder (300g)	12	15.28 ± 1.09[a]	15.30± 1.12[a]	15.37 ± 1.15[a]	16.12 ± 1.17[a]	16.18 ± 1.20[a]	16.21 ± 1.23[a]	17.02 ± 1.28[a]	17.14 ± 1.31[a]
Moringa Oleifera seed powder (300g)	12	14.25 ± 1.04[b]	14.29 ± 1.10[b]	14.34 ± 1.12[b]	15.37 ± 1.14[b]	15.40 ± 1.17[b]	15.43 ± 1.20[b]	16.13 ± 1.24[b]	16.16 ± 1.29[b]

Mean along the column having different superscript of alphabets differ significantly at P ≤ 0.05 by least significant difference

Mean fin length of catfish measured from untreated pond water and treated pond water with bio-coagulants

Mean fin length of catfish measured from untreated pond water and treated pond water with Snail shell powder (300g) and *Moringa Oleifera* seed powder (300g) is presented in Table 4.7. The results obtained revealed that there was a significant difference (p>0.05) in mean fin length of catfish treated with Snail shell powder (300g) and *Moringa Oleifera* seed powder relative to the control. Accordingly, increase in mean fin length of catfish was observed to correspondingly increase as the week of bio-coagulants treatments increased. The highest mean fin length of catfish samples treated with Snail shell powder (300g) was recorded at 16 weeks after bio-coagulants (8.21 ± 0.97 cm) when compared with the control with a mean value of 6.19 ± 0.84 cm while the least mean fin length was recorded at two (2) WAB (5.13 ± 0.43 cm). *Moringa Oleifera* seed powder (300g) at 16 WAB recorded the highest mean catfish fin length (7.18 ± 0.90 cm) while the least was recorded from two (2) WAB (4.05± 0.48 cm). However, mean values of fin length of catfish species were significantly (P<0.05) higher on treatment with Snail shell powder (300g) than *Moringa Oleifera* seed powder (300g).

Mean fin length of catfish measured from untreated pond water and treated pond water with bio-coagulants

Treatments	Number measured	Weeks after bio-coagulants (WAB)							
		Number and mean fin of catfish measured (cm)							
		2 WAB	4 WAB	6 WAB	8 WAB	10 WAB	12 WAB	14 WAB	16 WAB
Control (0g)	12	3.23 ± 0.32[c]	3.25 ± 0.38[c]	4.28 ± 0.52[c]	4.31 ± 0.68[c]	5.17 ± 0.71[c]	5.21 ± 0.75[c]	6.11 ± 0.81[c]	6.19 ± 0.84[c]
Snail shell powder (300g)	12	5.13 ± 0.43[a]	5.16 ± 0.47[a]	6.13 ± 0.69[a]	6.15 ± 0.73[a]	7.01 ± 0.79[a]	7.11 ± 0.81[a]	8.12 ± 0.94[a]	8.21 ± 0.97[a]
Moringa Oleifera seed powder (300g)	12	4.05± 0.48[b]	4.11± 0.41[b]	5.12± 0.58[b]	5.15± 0.71[b]	6.04 ± 0.74[b]	6.21 ± 0.79[b]	7.13 ± 0.87[b]	7.18 ± 0.90[b]

Mean along the column having different superscript of alphabets differ significantly at P ≤ 0.05 by least significant difference

Mean weight of catfish recorded from untreated pond water and treated pond water with bio-coagulants

Mean weight of catfish of catfish measured from untreated pond water and treated pond water with Snail shell powder (300g) and *Moringa Oleifera* seed powder (300g) is presented in Table 4.8. The results obtained revealed that there was a significant difference

*Corresponding Author: **Nwamba, I.M.**

(p>0.05) in mean weight of catfish of catfish treated with Snail shell powder (300g) and *Moringa Oleifera* seed powder relative to the control. Accordingly, increase in mean weight of catfish of catfish was observed to correspondingly increase as the week of bio-coagulants treatments increased. The highest mean weight of catfish of catfish samples treated with Snail shell powder (300g) was recorded at 16 weeks after bio-coagulants (1.147 ± 0.95 cm) when compared with the control with a mean value of 0.903± 0.61 cm while the least mean weight of catfish was recorded at two (2) WAB (0.73 ± 0.21 cm). *Moringa Oleifera* seed powder (300g) at 16 WAB recorded the highest mean catfish weight of catfish 1.104 ± 0.70 cm) while the least was recorded from two (2) WAB (0.64 ± 0.18 cm). with respect to the two treatments used, mean values of weight of catfish of catfish species were significantly (P<0.05) higher on treatment with Snail shell powder (300g) than *Moringa Oleifera* seed powder (300g).

Mean weight of catfish recorded from untreated pond water and treated pond water with bio-coagulants

Treatments	Number measured	Weeks after bio-coagulants (WAB)							
		Number and mean weight of catfish measured (kg)							
		2 WAB	4 WAB	6 WAB	8 WAB	10 WAB	12 WAB	14 WAB	16 WAB
Control (0g)	12	0.51 ± 0.13^{c}	0.57 ± 0.17^{c}	0.74 ± 0.23^{c}	0.103 ± 0.31^{c}	0.235 ± 0.38^{c}	0.586 ± 0.43^{c}	0.791 ± 0.52^{c}	0.903± 0.61^{c}
Snail shell powder (300g)	12	0.73 ± 0.21^{a}	0.82 ± 0.32^{a}	0.109 ± 0.41^{a}	0.145 ± 0.53^{a}	0.571 ± 0.67^{a}	0.707 ± 0.73^{a}	0.912 ± 0.88^{a}	1.147 ± 0.95^{a}
Moringa Oleifera seed powder (300g)	12	0.64 ± 0.18^{b}	0.69 ± 0.25^{b}	0.92 ± 0.34^{b}	0.125 ± 0.39^{b}	0.349 ± 0.45^{b}	0.653 ± 0.59^{b}	0.809 ± 0.68^{b}	1.104 ± 0.70^{b}

Mean along the column having different superscript of alphabets differ significantly at P ≤ 0.05 by least significant difference

Discussion

In this study, the use of natural biocoagulants in pond wastewater treatments was investigated. The results revealed a significant difference (p<0.05) in the Appearance, Colour, Odour, Turbidity, Temperature, Dissolved Oxygen, Biological Oxygen Demand Sulphate and total suspended solids before and after treatment with shell powder coagulant and *Moringa oleifera* seed powder coagulant. This corroborates the reports of Darwin et al. (2024). A study by Dar et al. (2018) also reported significant differences in physicochemical properties of pond water before and after treatments with snail shell powders.

pH is among the very significant chemical characteristic of all waters, which explains certain significant biotic and abiotic ecological characteristics of aquatic systems in general. The values of the water pH were only slightly acidic but were within the acceptable limit for water set by the world health organization (WHO, 2006). The slightly acidic pH range recorded in this study conformed to values previously reported in Niger Delta freshwaters (Alsharari et al., 2018). This finding also corroborates the report of Adebayo et al. (2020). The desirable range for pond pH is 6.5 - 9.5 and acceptable range is 6.5-8.5 (WHO, 2006). The range of the pH obtained from this study agrees with Stone and Thomforde (2023). Thus, good pond productivity and fish health can be maintained. Furthermore, Kamal et al. (2007) who reported a range of 7.3 - 8.3 obtained a similar range which is at variance with the pH range obtained in this study.

Generally, the physicochemical parameters analyzed fell within the desirable and acceptable limits (WHO, 2006). However, significant pollution of the fishponds was indicated from the result of the parameters analyzed. This conforms to the report of Adebayo et al. (2020) on their study on physicochemical properties of pond waters in Ondo State.

The quantitative analysis of the *M. oleifera* used in this study showed the presence of bioactive compounds such as Alkaloids, Flavonoids, Saponins, Cardiac glucosides (%) and Anthraquinone (mg/100g) in the plant extracts. Cardiac glucosides yielded the highest phytoconstituents with a mean value of 44.44 ± 5.31 (%) while the least value was gotten from Terpenoids with a mean value of 1.13 ± 0.07. However, this is different from similar studies which showed Flavonoids and saponins as the highest proportion of phytochemicals (Altaher et al., 2019).

Evidence based scientific reports in this study lend credence to the value of *M. oleifera* (Ang & Mohammad, 2020) and documented evidence suggested that *M. oleifera* remains a very rich source of extract and chemical compounds with diverse bioactivities that are of therapeutic benefit to man including the treatment of waste water as researched by previous authors (Asrafuzzaman et al., 2021; Samje, Metuge, Mbah, Nguesson, & Cho-Ngwa, 2014).

The *M. oleifera* seeds contain soluble protein, which serves as a clarifying agent and destabilizes the particles in the water (Garde et al. 2017). The study of Tunggolou and Payus (2017) showed the most significant finding of using *M. oleifera* as biocoagulant which achieved the high purification of pond water. The ability of *M. oleifera* to reduce the reduce the physicochemistry of the pond water sample could be due to their coagulation such as adsorption and neutralization of the positive charges colloidal in the water. It has been established by Garde et al. (2017) that *Moringa seed* validates its potential to act as a natural coagulant in water treatment, as its dimeric cationic proteins neutralize and adsorb particles present in water . Due to electrostatic interactions, the negatively charged particles of the contaminants are attracted by the cationic charges of the *Moringa oleifera* protein, leading to the accumulation of the particles, elevation of their molecular weight and subsequent sedimentation (Garde et al. 2017).

The results from this study also showed that snail shell powder contained minerals such as sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), phosphorus (P), iron (Fe) and manganese (Mn). Among the mineral composition, calcium recorded the highest mean concentration (14177.58 ± 111.17 mg/100g) followed by phosphorus (202.04 ± 28.95 mg/100g) while the least mineral recorded from the snail shell powder was manganese (0.17 ± 0.02 mg/100g). This aligns with the findings of Lu et al. (2024) but agrees with the reports of ku et al. (2022). Previous researchers had established the efficacy of snail shell powder in water purification (Copat et al., 2020).

The determination growth performance had been reported to be of major interest, since apart from predicting the average weight of the fish at a given length, it is equally employed in assessing the well-being of the fish population in a given water body as well as providing very important information about a population by describing the structural characteristics within the population (Ekekeotu, 2020). The results of growth performance revealed that there was a significant difference ($p>0.05$) in mean length, Width, head circumference, fin length and weight of catfish treated with Snail shell powder (300g) and *Moringa Oleifera* seed powder relative to the control. Increase in growth of catfish was observed to correspondingly increase as the week of bio-coagulants treatments increased. The average final mean length, Width, head circumference, fin length and weight differed ($P<0.05$) from those cultured with control water. This is similar to the report of Ekekeotu (2020).

Conclusion

This research examined the application of Snail shell and *M. oleifera* seeds powders as a bio-coagulant for water treatment and its reuse in aquaculture. The results obtained from the treatment with *Moringa oleifera* are encouraging especially at optimum dosages. The data has shown that the seed of *Moringa* contains some coagulating substances capable of removing turbidity to WHO standard. Thus, bio-coagulant extracted from snail shell and *M. oleifera* powders are suitable for treating pond water for drinking purposes. From the research, results of snail shell materials had higher treatment potentials than *M. oleifera* powder; it is shown that modification will be a good research direction to increase the adsorption capacity by increasing the surface of the shell material

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