WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Efficiency of Three Indigenous Legumes Seed Powder (*Moringa Oleifera, Afzelia Africana* And *Muccuna Flagellipse*) as Biocoagulants for Urban Wastewater Treatment.

Osinomumu, I.O.[1*], Okechukwu, R.I.[1] & Duru, C.M.[1]

[1]Department of Biology, Federal University of Agriculture, Owerri, Imo State.

ABSTRACT

This present study was design to assess the coagulating efficacy of three different indigenous plant (*Moringa oleifera, Afzelia africana* and *Muccuna flagellipse*) seed powders as bio-coagulant in wastewater and groundwater treatment. Fresh, healthy and matured seeds of *Moringa oleifera, Afzelia africana* and *Muccuna flagellipse* were bought from relief market Owerri and processed into fine powders. Qualitative phytochemicals screening of aqueous extracts of the seed powders were carried out while physicochemical and bacterial analysis of the waste samples collected from Somachi slaughter (slaughterhouse wastewater) and Eziobodo (groundwater), Owerri Municipal were assessed before and after treatment. Three (3) different fresh stock solutions (SS) (15g/300ml, 30g/300ml and 45g/300ml) of the seed powders were freshly prepared. 100ml each of the water sample was measured into clean 250ml beaker and 10ml/20ml fresh stock solution each was added and labeled accurately. The mixtures were stirred and allowed to stand for 24 hours for effective contact before filtering. Physicochemical parameters such as colour, odour, appearance was checked using ten (10) different observers while pH, turbidity, electrical conductivity (EC), total dissolved solids (TDS), biological oxygen demand (BOD), dissolved oxygen (DO) and chloride (Cl-) were assessed according to standard technique. The result revealed the presence of phytochemicals; alkaloids, flavonoid, phenols, tannins, steroids, saponins, and anthraquinones in *M.oleifera, A.africana* and *M.flagllipes* with an exception of steroids in *M. flagellipes* and *A. africana*. The physicochemical properties of the water samples before treatment shows that the slaughterhouse wastewater sample was brown in colour, highly turbidity, poor in appearance and almost odourless while groundwater sample was completely colourless, odourless, clear with excellent appearance. After treatment with 10mL and 20mL fresh SS, there was an observed decrease in the level of turbidity, pH, temperature, and BOD with an increase in the level of DO and Cl- among the different treatment at their respective concentration. *M. oleifera* was the best with evidence of least mean turbidity, followed by *A. africana* and *M. flgellipes*. In addition, the treatment of groundwater indicates a change in colour, odour, appearance, and pH, which compare favorably with the control while temperature, EC, TDS, DO, BOD and Cl- were statistically the same before and after treatment,while the turbidity increases across the different treatment. Conversely, the result of the bacterial screening before and after treatment, reveals the presence of coliforms (Escherichia coli, Streptococcus spp, Enterobacter spp.,) and pathogenic bacteria (Pseudomonas spp., Staphylococcus aureus, and Campylobacter jejuni). The treatment with *M. oleifera* has the least bacteria count followed by A. africana and Muccuna flagellipes. The bacteria count for groundwater before and after treatment was significantly the same with exception in the treatment with *M. flagellipes* which showed a slight increase in E. coli and *C. jejuni*, although, was still within range WHO allowable bacterial count for domestic water (100-500/ml) of colony-forming units. Therefore, the use of M. oleifera as bio-coagulant should be adopted in the treatment of wastewater as it does not only improve the wastewater quality but also reduces the load of pathogenic bacterial.

Keywords: biocoagulants, *Moringa oleifera*, *Afzelia Africana, Muccuna flagellipse*, Urban Wastewater, Treatment.

Introduction

Water is a basic human need and a very essential requirement of any society. Studies have shown that large populations in rural and peri-urban areas of Africa have no access to safe drinking water. This has in turn resulted to the spread of waterborne diseases. Although lack of clean drinking water is a global health threat especially in most developing countries whose populaces are coerced into use turbid and contaminated water for domestic purposes.

Since the 1990s, the problem of water pollution has worsened in almost all rivers in Africa, Latin America, and Asia [1]. The deterioration of water quality is expected to intensify in the coming decades [2]. According to [1] it is estimated that 80% of all domestic and industrial wastewater worldwide is discharged into the environment without any prior treatment, resulting in increasing overall water quality deterioration and causing harmful effects on human health, ecosystems, and sustainable development [3]. More so, wastewater discharge is increasing continuously due to industrial development and the rise in the living standards of the world's population. The self-purification capacities have been exceeded, which forces researchers to develop new techniques to purify these effluents [4]

Wastewater purification is viewed as a set of techniques that are employed to treat wastewater either for reuse or recycling in the natural environment. Conventional waste water treatment processes (chemical precipitation, adsorption on activated carbon, ion exchange, evaporation, and membrane processes) entail major difficulties in removing metallic elements [5]. Conventionally, the enmeshment and removal of the colloids in water could be achieved by coagulation, using certain chemical coagulants like certified alum. For many developing countries, this treatment process is not feasible because of the high costs involved and the difficulty in assessing chemical coagulants including alum. Moreover, recent studies have pointed out the health threats arising from the consumption of residual aluminium present in water, such as Alzheimers diseases and neurodegenerative illness [6-12]. Other serious setbacks includethe production of large sludge volumes, alteration of water pH and poor coagulation efficiency in cold weather.

In other to address these challenges, many researchers have investigated the potential of natural coagulants such as botanicals (plant parts) as water additives, in other to produce potable water, and they are found to be potential natural coagulants based on the remarkable coagulating properties reposed in them. Notable plant species studied with promising coagulating effects were *Moringa oleifera* (Linn.), *Cactus latifaira* and *Prosopis jaliflora* [13]. So far, many researches have revealed the ability of *M. oleifera* seed powder in reducing water effluent to a recommendable level. As a result of this, the seed was used as a primary coagulant for turbidity removal on raw and synthetic-turbid water.

The cost of this natural coagulant would be less expensive compared to the conventional coagulant (alum) for water purification, since it is available in most rural communities in Nigeria where treated water is a scarce resource. However, there is dearth of information reported on the use of indigenous plant species such as *Moringa oleifera, Afzelia africana* and *Muccuna flagellipse* seed powder as a coagulant in wastewater treatment, in Nigeria, particularly in Imo State. It is in this light that this research was carried out to confirm the efficiency of powdered extracts of dried *Moringa oleifera, Afzelia africana* and *Muccuna flagellipse* seeds, which is commonly available in most communities in the country in the treatment of Urban Wastewater Treatment.

Materials and Methods

Study Area

This research work was carried out in the Biology laboratory, School of Biological Sciences, Federal University of Technology, Owerri. The mean temperature of the laboratory ranges from 27°C-30°C and the mean relative humidity 81%- 90%. The Federal University of Technology Owerri lies between latitude 05° 21' and 05° 42'North and longitude 07° 48' and 06° 53'East. Owerri consists of tropical rainforest zone with average annual rainfall distribution of 2,250-2800mm.

Coagulants used

The three different leguminous plant seeds were collected from Owerri metropolis. Matured and naturally dry seedpods of *Moringa oleifera* (brown in colour) was harvested from a healthy Moringa tree in a botanical garden of Federal University of Technology, Owerri. While dried, matured, and healthy seeds of *Afzelia africana* and *Muccuna flagellipes* were bought from Relief market Owerri. The samples were identified and authenticated by Dr. C. M. Duru, plant biosystematist Biology Department, Federal University of Technology Owerri.

Sample preparation

The methodology of Dehghani & Alizadeh, (2016) with slight modification was used. The seeds of Moringa oleifera were 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 Seeds of *Afzelia africana*(Akparata)

The seeds of Afzelia Africana were soaked in water overnight to soften the seed before cracking with hammer. The seed kernels were dried in an oven at 350C for 5 hours using the method described by Dehghani & Alizadeh, (2016). The dried seeds were triturated to fine powder using home blender and then, stored in an airtight plastic container for further use.

Preparation of Seeds of *Muccuna flagellipes* (Ukpo)

The methodology of Dehghani & Alizadeh, (2016) with slight modification was used. The seeds ofMuccuna flagellipes were cracked manually with hammer to remove the seed kernels and then, dried in an oven at 350Cfor 5 hours to make sure they were properly dried before triturating into fine powder with home blender and then, stored in an airtight plastic container for further use.

Waste water and Ground water sample Collection

Wastewater used in this study was collected randomly at different point (upper stream, mid- stream and downstream) from Somachi slaughterhouse in Owerri municipal into 10 litres gallon while groundwater was collected from different borehole in Eziobodo village into 10litres gallon. The water samples were transported immediately to the laboratory for analysis.

Physicochemical Parameters

Physicochemical parameters such as colour, odour, taste, appearance, turbidity, pH, electrical conductivity, total dissolved solid, biological oxygen demand, dissolved oxygen, and chloride ion were determined following the standard protocols and methods of American Public Health Organization (APHA) (1995) and American Society for Testing and Materials (ASTM) using different calibrated standard instruments. The temperature, pH, and conductivity were analyzed on-site immediately after samples collection.

Phytochemical Analysis

The preliminary qualitative phytochemical screening was carried out according to the method described by Harbone (1998), Parekh & Chanda (2007). The extracts from the different samples were assessed for the presence/absence of the following phytochemicals parameter: saponins, flavonoids, alkaloids, tannins, phenols, anthraquinones and steroids.

Bacteria Screening

The bacteria load for each sample was checked before and after treatment to ensure that the water is safe for domestic use. This was achieved by culturing the samples using nutrient media according to the method described by Prescott,(1999).Nutrient agar was prepared and pour in an autoclaved petri-dishes after autoclaving the media. Upon solidification of the media, a sterilized wire loop was used in inoculating the sample via streak plate method and then incubated at 370C for 24 hours. The growth was subjected to biochemical test for proper identification of the isolates.

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

Phytochemical Analysis of the Plant Seed Samples used as Bio-coagulants

The phytochemical parameter of the plant seed samples used as bio-coagulant is shown in **Table 1**. The result reveals the presence of the following phytochemicals; alkaloids, flavonoids, phenols, tannins, steroids, and anthraquinones in all the plant seed samples. While steroids were only present in *M. oleifera*

Table 1:Phytochemical Analysis of the Plant Seed Samples used as Bio-coagulants

S/N	PARAMETERS	*Moringaoleifera*	*Afzeliaafricana*	*Muccuna flagellipse*
1	**Alkaloids**	+	+	+
2	**Flavonoids**	+	+	+
3	**Phenols**	+	+	+
4	**Tannins**	+	+	+
5	**Steroids**	+	-	-
6	**Saponins**	+	+	+
7	**Anthraquinones**	+	+	+

Legend:

+ = Present

-=Absent

Physicochemical parameters of water samples collected from Somachi slaughter houseand Eziobodo groundwater before and treatment with alum

The result of physicochemical analysis before treatment and after treatment with alum shows significant difference in the colour, odour, appearance, turbidity, temperature, dissolved oxygen, biological oxygen demand and chloride ion after treatment with alum for slaughterhouse waste water,as there was an increase in the mean value of colour from (33-100), odour (92-100), appearance (31- 100), dissolved oxygen (4.20-5.78) and chloride ion (1.42-2.14) and decreased in turbidity (0.86-0.13), Temperature (31-29), and biological oxygen demand (7.59-2.05). Groundwater before treatment and slaughterhouse wastewater after treatment were significantly higher than slaughterhouse wastewater before treatment in colour, odour and appearance.

Table 2:Physicochemicalpropertiesofslaughterhousewastewaterandgroundwaterbefore and after treatment with alum

Physicochemical properties	WHO Standard	Beforetreatmentwithalum		Aftertreatmentwithalum	
		Slaughterhouse wastewater	Groundwater	Slaughterhouse wastewater	Groundwater

Colour	-	$33^{b}\pm4.3$	$100^{a}\pm1.0$	$100^{a}\pm1.0$	$100^{a}\pm1.0$
Odour	-	$92^{b}\pm7.2$	$100^{a}\pm1.0$	$100^{a}\pm1.0$	$100^{a}\pm1.0$
Appearance	-	$31^{b}\pm4.1$	$100^{a}\pm1.0$	$100^{a}\pm1.0$	$100^{a}\pm1.0$
Turbidity(Opt.Index)	-	$0.86^{a}\pm0.3$	$0.02^{c}\pm0.01$	$0.13^{b}\pm0.2$	$0.02^{c}\pm0.01$
pH	6.5-8.5	$6.62^{a}\pm1.3$	$7.19^{a}\pm1.5$	$7.12^{a}\pm1.2$	$7.14^{a}\pm1.4$
Temperature(^{O}C)	-	$31^{b}\pm4.1$	$21^{b}\pm3.3$	$29^{a}\pm5.4$	$21^{b}\pm3.3$
Electricalconductivity (µs/Cm)	1000	$195^{b}\pm21.4$	$214^{a}\pm26.6$	$187^{b}\pm20.2$	$215^{a}\pm26.7$
Totaldissolvedsolids (Mg/L)	1000	$327^{a}\pm31.7$	$253^{b}\pm27.8$	$305^{a}\pm29.6$	$252^{b}\pm27.7$
Dissolvedoxygen(Mg/L)	6.5-8.0	$4.20^{c}\pm1.2$	$7.13^{a}\pm1.8$	$5.78^{b}\pm1.5$	$7.14^{a}\pm1.9$
Biologicaloxygen demand(Mg/L)	6	$7.59^{a}\pm1.7$	$1.56^{b}\pm0.09$	$2.05^{b}\pm0.1$	$1.54^{b}\pm1.7$
Chlorideion	250	$1.42^{c}\pm0.7$	$3.80^{a}\pm1.1$	$2.14^{b}\pm0.9$	$3.83^{a}\pm0.7$

Meanalongtherowhavingdifferentsuperscriptoflettersdiffersignificantlyat$P=0.05$usingDuncan Multiple Range Test.

Physicochemical properties before and after treatment with 15g/300mL Stock Solution from the plant material used

The Physicochemical properties before and after treatment with 10mL and 20mL of 15g/300mL Stock Solution (SS) indicates that there was a significant difference in the colour, appearance, odour, turbidity, pH, Temperature, dissolved oxygen, biological oxygen demand and chloride after treatment of the slaughterhouse wastewater with 15g/300mL SS at 10mL and 20mL accordingly. The increase in mean colour from (33-41) at 10mL; (33-42) at 20mL and (33-43) at 20mL, appearance (31-37) at 10mL; (31-39) at 20mL and (31-37) at 20mL was seen in the treatment with Moringa oleifewra and Afzelia africana respectively. There was a decrease in odour of which treatment with M. oleifera at 10mL and Muccuna flagellipes at 10mL and 20mL are significantly the same while, *A. africana* at 10mL and 20mL and M. oleifera at 20mL were significantly the same. Also, there was in decrease in turbidity of which the treatment with M.oleifera hastheleast mean turbidity(0.31)at10mLand(0.40) at 20mL. in addition, the decrease in pH and temperature and increase dissolved oxygen were significantly the same across the different treatment Furthermore, the decrease in biological oxygen demand and increase in chloride ion was the same statistical for treatment with M. oleifera and A. africana at 10mL and 20mL than that of M. flagellipes accordingly.

Conversely, there was a decrease in the colour, odour, appearance and pH, of which the change in colourodour and pH were statistically the same across the different treatment while in appearance, treatmentwith10mL M.oleifera and A.africana were significantly the same andbetterthan20mLof M. oleifera and A. africana and M. flagellipes at 10mL and 20mL. temperature, electrical conductivity, total dissolved solids, dissolved oxygen, biological oxygen demand and chloride were statistically the same before and after treatment.

Table4.3:Physicochemicalpropertiesbeforeandaftertreatmentwith15g/300mLStock Solution from the plant material used

Slaughterhousewastewaterbeforeandaftertreatmentat15g/300mlstocksolution								
Physicochemical properties	**WHO standard**	**Before treatment**		**10ml**			**20 ml**	
			Moringa olifera	***Afzelia africana***	***Muccuna flagellipes***	***Moringa olifera***	***Afzelia africana***	***Muccuna flagellipes***
Colour	-	$33^{b}\pm4.3$	$41^{a}\pm5.8$	$34^{b}\pm2.6$	$34^{b}\pm2.6$	$42^{a}\pm5.9$	$43^{a}\pm3.0$	$35^{b}\pm2.7$
Odour	-	$92^{a}\pm7.2$	$37^{c}\pm4.6$	$41^{b}\pm3.4$	$38^{c}\pm2.8$	$41^{b}\pm5.8$	$45^{b}\pm3.7$	$36^{c}\pm2.6$
Appearance	-	$31^{b}\pm4.1$	$37^{a}\pm4.6$	$28^{b}\pm1.7$	$27^{b}\pm1.6$	$39^{a}\pm4.9$	$37^{a}\pm2.2$	$28^{b}\pm1.7$
Turbidity(Opt.Index)	-	$0.86^{b}\pm0.3$	$0.31^{e}\pm0.2$	$0.69^{c}\pm0.5$	$0.46^{d}\pm0.3$	$0.40^{d}\pm0.4$	$0.92^{b}\pm0.8$	$1.01^{a}\pm0.5$
pH	6.5-8.5	$6.62^{a}\pm1.3$	$4.79^{a}\pm0.6$	$5.12^{a}\pm1.2$	$5.55^{a}\pm1.6$	$4.87^{a}\pm0.8$	$5.02^{a}\pm1.0$	$5.55^{a}\pm1.6$
Temperature(^{O}C)	-	$31^{a}\pm4.1$	$23^{b}\pm2.4$	$23^{b}\pm2.4$	$22^{b}\pm2.3$	$23^{b}\pm2.4$	$23^{b}\pm2.4$	$22^{b}\pm2.2$

Electricalconductivity (µs/Cm)	1000	195^{a}±21.4	196^{a}±21.6	191^{a}±28.2	182^{a}±26.9	194^{a}±23.3	190^{a}±27.4	182^{a}±26.9
Totaldissolvedsolids (Mg/L)	1000	327^{a}±31.7	287^{a}±23.9	291^{a}±33.6	298^{a}±34.5	293^{a}±24.2	296^{a}±35.1	299^{a}±35.2
Dissolvedoxygen(Mg/L)	6.5-8.0	4.20^{b}±1.2	6.27^{a}±1.6	5.58^{a}±1.5	5.05^{a}±1.2	6.27^{a}±1.6	5.58^{a}±1.5	5.08^{a}±1.4
Biologicaloxygen demand(Mg/L)	6.00	7.59^{a}±1.7	3.84^{c}±0.9	4.02^{c}±1.1	5.12^{b}±1.8	3.98^{c}±1.5	4.09^{c}±1.4	5.16^{b}±2.0
Chlorideion	250	1.42^{c}±0.7	3.08^{a}±1.1	2.87^{a}±0.2	2.11^{b}±0.1	3.06^{a}±1.0	2.63^{a}±0.1	2.14^{b}±0.2
Groundwaterbeforeandaftertreatmentat15g/300mlstocksolution								
Colour	-	100^{a}±1.0	46^{b}±6.2	47^{b}±4.0	43^{b}±3.4	49^{b}±6.2	46^{b}±3.7	44^{b}±3.4
Odour	-	100^{a}±1.0	40^{b}±4.9	46^{b}±3.8	39^{b}±2.9	46^{b}±6.6	41^{b}±3.2	45^{b}±2.9
Appearance	-	100^{a}±1.0	40^{b}±4.9	43^{b}±22	37^{c}±2.5	39^{c}±4.9	38^{c}±2.3	39^{bc}±4.9
Turbidity	-	0.02^{d}±0.01	0.12^{c}±0.1	0.22^{b}±0.3	0.42^{a}±0.1	0.40^{a}±0.4	0.30^{a}±0.3	0.32^{a}±0.4
pH	6.5-8.5	7.19^{a}±1.5	5.00^{b}±0.8	5.56^{b}±1.6	6.46^{ab}±1.9	5.02^{b}±0.9	5.22^{b}±1.3	5.43^{b}±2.0
Temperature(^{O}C)	-	21^{a}±3.3	20^{a}±2.1	20^{a}±2.2	23^{a}±2.4	20^{a}±2.1	23^{a}±2.4	22^{a}±3.2
Electricalconductivity (µs/Cm)	1000	214^{a}±26.6	201^{a}±23.2	200^{a}±29.3	199^{a}±28.1	201^{a}±26.8	198^{a}±29.2	197^{a}±29.0
Totaldissolvedsolids (Mg/L)	1000	253^{a}±27.8	265^{a}±28.8	270^{a}±34.7	270^{a}±31.6	262^{a}±21.2	216^{a}±28.4	258^{a}±32.4
Dissolvedoxygen(Mg/L)	6.5-8.0	7.13^{a}±1.4	6.53^{a}±1.7	6.10^{b}±1.8	6.03^{b}±1.7	5.51^{b}±1.1	6.11^{b}±1.8	6.01^{b}±1.4
Biologicaloxygen demand(Mg/L)	6.00	1.56^{a}±0.9	1.65^{a}±0.2	1.67^{a}±0.4	1.90^{a}±0.7	1.66^{a}±1.0	1.73^{a}±0.6	1.89^{a}±0.6
Chlorideion	250	3.80^{a}±1.1	3.45^{a}±1.3	3.52^{a}±0.5	3.48^{a}±0.6	4.36^{a}±1.8	3.48^{a}±0.3	3.51^{a}±0.4

Meanalongtherowhavingdifferentsuperscriptoflettersdiffer significantlyatP=0.05usingDuncanMultiple Range Test.

Physicochemical properties before and after treatment with 30g/300mL Stock Solution from the plant material used.

Table 4.4 shows that there was a significant change in the colour, odour, appearance, turbidity, pH, temperature, dissolved oxygen, biological oxygen demand and chloride ion for slaughterhouse wastewater treatment. An increase in colour (33-41) at 10mL; (33-40) at 20mL and (33-39) at 20mL was recorded against treatment with Moringa oleifera and Afzelia africana respectively, appearance (31-40) at 10mL and (31-44) at 20mL for M. oleifera. The decrease in turbidity was least in treatment with M. oleifera (0.86-0.102) at 10mL and (0.86-0.21) at 20mL, pH, treatment with 10mL of M. oleifear was the least while others were significantly the same. The decrease in temperature and increase in dissolved oxygen were significantly the same. While, in biological oxygen demand and chloride ion, M. oleifera and A. africana were significantly the same. In addition, electrical conductivity and total dissolved solids were statistically the same before and after treatment.

Similarly, the physicochemical properties for groundwater treatment with 30g/300mL SS of the different plant materials used. Physicochemical properties such as colour, odour, appearance and pH decreased after treatment but the decrease in colour (100-47) and odour (100-40) were statistically the same while in appearance, M. oleifera and A. africana at 10mL have the highest appearance than M. oleifera and A. africana at 20mL and M. flagellipes at 10mL and 20mL respectively. The turbidity increasedacrossthedifferenttreatment,withthehighestturbidityrecordedat20mLSSofM.oleifera,

A. africana and M. flagellipes from 0.02-0.38 and the least at 10mL SS of M. oleifera (0.02). furthermore,thetemperature,electricalconductivity,totaldissolvedsolids,biologicaloxygendemands and chloride ions were statistically the same before and after treatment.

Table4.4:Physicochemicalpropertiesbeforeandaftertreatmentwith30g/300mLStock Solution from the plant material used.

Slaughterhousewastewaterbeforeandaftertreatmentat30g/300mlstocksolution			
	WHO	**10ml**	**20 ml**

Physicochemical properties	**standar d**	**Before treatment**	***Moringa olifera***	***Afzelia africana***	***Muccuna flagellipes***	***Moringa olifera***	***Afzelia africana***	***Muccuna flagellipes***
Colour	-	$33^{b}\pm4.3$	$41^{a}\pm5.8$	$32^{b}\pm2.6$	$24^{c}\pm2.6$	$40^{a}\pm5.9$	$39^{a}\pm0.8$	$25^{b}\pm2.2$
Odour	-	$92^{a}\pm7.2$	$33^{c}\pm4.6$	$33^{b}\pm3.4$	$23^{c}\pm2.8$	$39^{b}\pm5.8$	$38^{b}\pm0.7$	$24^{c}\pm2.6$
Appearance	-	$31^{b}\pm4.1$	$40^{a}\pm4.6$	$34^{b}\pm3.7$	$33^{b}\pm3.6$	$44^{a}\pm4.9$	$31^{b}\pm3.4$	$34^{b}\pm3.7$
Turbidity(Opt.Index)	-	$0.86^{c}\pm0.7$	$0.10^{e}\pm0.2$	$0.83^{c}\pm0.5$	$0.92^{b}\pm0.9$	$0.21^{d}\pm0.4$	$1.0^{b}\pm0.2$	$1.12^{a}\pm0.13$
pH	6.5-8.5	$6.62^{a}\pm1.3$	$4.82^{b}\pm0.6$	$5.01^{a}\pm1.2$	$5.44^{b}\pm1.6$	$4.76^{a}\pm0.8$	$5.26^{a}\pm1.0$	$5.59^{a}\pm1.7$
Temperature(^{O}C)	-	$31^{a}\pm4.1$	$25^{b}\pm2.5$	$23^{b}\pm2.4$	$21^{b}\pm2.3$	$24^{b}\pm2.4$	$22^{b}\pm2.3$	$22^{b}\pm2.3$
Electricalconductivity (µs/Cm)	1000	$195^{a}\pm21.4$	$187^{a}\pm21.6$	$192^{a}\pm28.2$	$180^{a}\pm26.9$	$198^{a}\pm28.4$	$190^{a}\pm2784$	$178^{a}\pm26.9$
Totaldissolvedsolids (Mg/L)	1000	$327^{a}\pm31.7$	$294^{a}\pm23.9$	$289^{a}\pm33.6$	$300^{a}\pm34.5$	$301^{a}\pm24.2$	$301^{a}\pm35.1$	$300^{a}\pm35.2$
Dissolvedoxygen(Mg/L)	6.5-8.0	$4.20^{b}\pm1.2$	$6.34^{a}\pm1.6$	$5.54^{a}\pm1.5$	$5.03^{b}\pm1.2$	$5.61^{a}\pm1.6$	$5.61^{a}\pm1.5$	$5.03^{b}\pm1.4$
Biologicaloxygen demand(Mg/L)	6.00	$7.59^{a}\pm1.7$	$4.0^{c}\pm0.9$	$4.04^{c}\pm1.1$	$5.28^{b}\pm1.8$	$4.00^{c}\pm1.5$	$5.12^{c}\pm1.4$	$5.02^{b}\pm2.0$
Chlorideion	250	$1.42^{c}\pm0.7$	$3.20^{a}\pm1.1$	$2.62^{a}\pm0.2$	$2.14^{b}\pm0.1$	$3.70^{a}\pm1.0$	$2.45^{a}\pm0.1$	$2.11^{b}\pm0.2$
Groundwaterbeforeandaftertreatmentat30g/300mlstocksolution								
Colour	-	$100^{a}\pm1.0$	$47^{b}\pm6.2$	$42^{b}\pm4.0$	$42^{b}\pm3.4$	$47^{b}\pm6.2$	$46^{b}\pm3.7$	$38^{b}\pm3.4$
Odour	-	$100^{a}\pm1.0$	$40^{b}\pm4.9$	$39^{b}\pm3.8$	$38^{b}\pm3.9$	$40^{b}\pm6.3$	$40^{b}\pm3.2$	$39^{b}\pm2.9$
Appearance	-	$100^{a}\pm1.0$	$48^{b}\pm4.9$	$48^{b}\pm22$	$44^{c}\pm2.5$	$49^{c}\pm4.9$	$46^{c}\pm2.3$	$39^{c}\pm4.9$
Turbidity	-	$0.02^{d}\pm0.01$	$0.12^{c}\pm0.1$	$0.23^{b}\pm0.3$	$0.43^{a}\pm0.1$	$0.11^{a}\pm0.4$	$0.29^{a}\pm0.3$	$0.38^{a}\pm0.4$
pH	6.5-8.5	$7.19^{a}\pm1.5$	$5.05^{b}\pm0.8$	$5.56^{b}\pm1.6$	$6.43^{ab}\pm1.9$	$5.14^{b}\pm0.9$	$5.55^{b}\pm1.3$	$6.44^{ab}\pm2.0$
Temperature(^{O}C)	-	$21^{a}\pm3.3$	$22^{a}\pm2.1$	$22^{a}\pm2.2$	$22^{a}\pm2.4$	$21^{a}\pm2.1$	$21^{a}\pm2.4$	$21^{a}\pm3.2$
Electricalconductivity (µs/Cm)	1000	$214^{a}\pm26.6$	$202^{a}\pm23.2$	$200^{a}\pm29.3$	$189^{a}\pm28.1$	$202^{a}\pm26.8$	$200^{a}\pm29.2$	$197^{a}\pm29.0$
Totaldissolvedsolids (Mg/L)	1000	$253^{a}\pm27.8$	$266^{a}\pm19.8$	$268^{a}\pm34.7$	$267^{a}\pm31.6$	$267^{a}\pm21.2$	$268^{a}\pm19.7$	$262^{a}\pm32.4$
Dissolvedoxygen(Mg/L)	6.5-8.0	$7.13^{a}\pm1.4$	$6.12^{b}\pm1.7$	$6.10^{b}\pm1.8$	$6.03^{b}\pm1.7$	$6.26^{b}\pm1.1$	$6.10^{b}\pm1.8$	$6.02^{b}\pm1.4$
Biologicaloxygen demand(Mg/L)	6.00	$1.56^{a}\pm0.9$	$1.7^{a}\pm0.2$	$1.71^{a}\pm0.4$	$1.94^{a}\pm0.7$	$1.74^{a}\pm1.0$	$1.89^{a}\pm0.6$	$1.90^{a}\pm0.6$
Chlorideion	250	$3.80^{a}\pm1.1$	$3.46^{a}\pm1.3$	$3.54^{a}\pm0.5$	$3.51^{a}\pm0.6$	$3.61^{a}\pm1.8$	$3.47^{a}\pm0.3$	$3.49^{a}\pm0.4$

Meanalongtherowhavingdifferentsuperscriptoflettersdiffersignificantlyat$P=0.05$usingDuncanMultiple Range Test.

Table 3 **Physicochemical properties before and after treatment with 45g/300mL Stock Solution from the plant material used.**

Table 4.5 shows that physicochemical properties such as colour, odour, appearance, turbidity, pH, temperature, dissolved oxygen, biological oxygen demand and chloride ion changes significantly after treatment of slaughterhouse wastewater with 45g/300mL SS of the three different plant materials used. There was an increase in colour across the treatment of which *Moringa oleifera* and *A. africana* (33- 40); (33-42) and (33-40); (33-40) at 10mL and 20mL respectively were the highest, for appearance, *M. oleifera* and *A. africana* at 20mL have the best appearance at (45) and (40), while for odour, *M.oleifera* and *A. africana* at 20mL have the best odour at 37 and 38 respectively. Also, turbidity decreased across the different treatment but with a lesser turbidity recorded against treatment with *M. oleifera* (0.31) at 20mL, the decreased in temperature was significantly the same across the different treatments. In addition, electrical conductivity and total dissolved solids statistically the same before and after treatment. Th increase in dissolved oxygen and chloride were the same statistically while the increase in biological oxygen demand was more in treatmentwith *M.flagellipes* (5.17)andlesserat *M. oleifera* (3.98) both at 20mL.

Similarly, the treatment of groundwater shows that physicochemical properties such as colour, odour, appearance, and turbidity changes significantly as the colour decreased from 100-41, 38 and 48, odour, 100-39, 49, appearance, 100-44, 47 and turbidity, 0.02-0.15, 0.22, 0.42 accordingly. The decrease inpH across the different treatments were significantly the same after treatment. While the temperature, electrical conductivity, total dissolved solids, biological oxygen demand and chloride ion were statistically the same before and after treatment.

Table4.5:Physicochemicalpropertiesbeforeandaftertreatmentwith45g/300mLStock Solution from the plant material used.

Physicochemical properties	**WHO standard**	**Before treatment**	**10ml**			**20 ml**		
			Moringa olifera	***Afzelia africana***	***Muccuna flagellipes***	***Moringa olifera***	***Afzelia africana***	***Muccuna flagellipes***
Slaughterhousewastewaterbeforeandaftertreatmentat45g/300mlstocksolution								
Colour	-	33^{b}±4.3	40^{a}±5.8	40^{a}±2.6	36^{b}±2.6	42^{a}±5.9	40^{a}±3.0	27^{c}±2.7
Odour	-	92^{a}±7.2	32^{c}±4.6	37^{b}±3.4	28^{d}±2.8	37^{b}±5.8	38^{b}±3.7	26^{d}±2.6
Appearance	-	31^{c}±4.1	39^{b}±4.6	39^{b}±1.7	31^{c}±1.6	45^{a}±4.9	40^{b}±2.2	34^{c}±1.7
Turbidity	-	0.86^{d}±0.3	0.33^{e}±0.2	0.76^{c}±0.5	0.72^{d}±0.3	0.31^{e}±0.4	1.6^{b}±0.8	1.71^{a}±0.5
pH	6.5-8.5	6.62^{a}±1.3	4.78^{b}±0.6	5.19^{b}±1.2	5.44^{b}±1.6	4.79^{b}±0.8	5.50^{b}±1.0	5.46^{b}±1.6
Temperature(^{O}C)	-	31^{a}±4.1	24^{b}±2.4	22^{b}±2.4	22^{b}±2.3	24^{b}±2.4	22^{b}±2.4	23^{b}±2.2
Electricalconductivity (µs/Cm)	1000	195^{a}±21.4	189^{a}±21.6	188^{a}±28.2	178^{a}±26.9	187^{a}±23.3	189^{a}±27.4	178^{a}±26.9
Totaldissolvedsolids (Mg/L)	1000	327^{a}±31.7	293^{a}±23.9	289^{b}±33.6	300^{a}±34.5	296^{b}±24.2	291^{b}±35.1	303^{a}±35.2
Dissolvedoxygen(Mg/L)	6.5-8.0	4.20^{b}±1.2	6.20^{a}±1.6	5.30^{a}±1.5	5.13^{a}±1.2	6.32^{a}±1.6	5.40^{a}±1.5	5.21^{a}±1.4
Biologicaloxygen demand (Mg/L)	6.00	7.59^{a}±1.7	4.00^{c}±0.9	4.02^{c}±1.1	5.04^{b}±1.8	3.98^{c}±1.5	4.09^{c}±1.4	5.17^{b}±2.0
Chlorideion	250	1.42^{c}±0.7	3.02^{a}±1.1	2.52^{a}±0.2	2.02^{b}±0.1	3.04^{a}±1.0	2.64^{a}±0.1	2.13^{b}±0.2
Groundwaterbeforeandaftertreatmentat45g/300mlstocksolution								
Colour	-	100^{a}±1.0	48^{b}±6.2	41^{c}±4.0	41^{c}±3.4	49^{b}±6.2	41^{c}±3.7	38^{d}±3.4
Odour	-	100^{a}±1.0	41^{b}±4.9	39^{c}±3.8	37^{b}±2.9	49^{b}±6.6	38^{b}±3.2	38^{b}±2.9
Appearance	-	100^{a}±1.0	47^{b}±4.9	44^{c}±22	44^{c}±2.5	41^{c}±4.9	44^{c}±2.3	44^{c}±4.9
Turbidity	-	0.02^{d}±0.01	0.15^{c}±0.1	0.22^{b}±0.3	0.42^{a}±0.1	0.11^{c}±0.4	0.21^{b}±0.3	0.39^{a}±0.4
pH	6.5-8.5	7.19^{a}±1.5	5.01^{b}±0.8	5.55^{b}±1.6	6.42^{ab}±1.9	5.03^{b}±0.9	5.53^{b}±1.3	6.43^{b}±2.0
Temperature(^{O}C)	-	21^{a}±3.3	22^{a}±2.1	21^{a}±2.2	22^{a}±2.4	22^{a}±2.1	22^{a}±2.4	22^{a}±3.2
Electricalconductivity (µs/Cm)	1000	214^{a}±26.6	198^{a}±23.2	201^{a}±29.3	189^{a}±28.1	268^{a}±26.8	198^{a}±29.2	183^{a}±29.0
Totaldissolvedsolids (Mg/L)	1000	253^{a}±27.8	276^{a}±19.8	268^{a}±34.7	269^{a}±31.6	264^{a}±21.2	264^{a}±19.7	270^{a}±32.4
Dissolvedoxygen(Mg/L)	6.5-8.0	7.13^{a}±1.4	6.47^{a}±1.7	6.08^{b}±1.8	6.03^{b}±1.7	6.03^{b}±1.1	6.12^{b}±1.8	6.03^{b}±1.4
Biologicaloxygen demand (Mg/L)	6.00	1.56^{a}±0.9	1.79^{a}±0.2	1.92^{a}±0.4	1.93^{a}±0.7	1.91^{a}±1.0	1.91^{a}±0.6	1.90^{a}±0.6

Chlorideion	250	3.80[a]±1.1	3.48[a]±1.3	3.53[a]±0.5	4.52[a]±0.6	3.53[a]±1.8	3.53[a]±0.3	3.49[a]±0.4

Meanalongtherowhavingdifferentsuperscriptoflettersdiffersignificantlyat P=0.05usingDuncanMultiple Range Test.

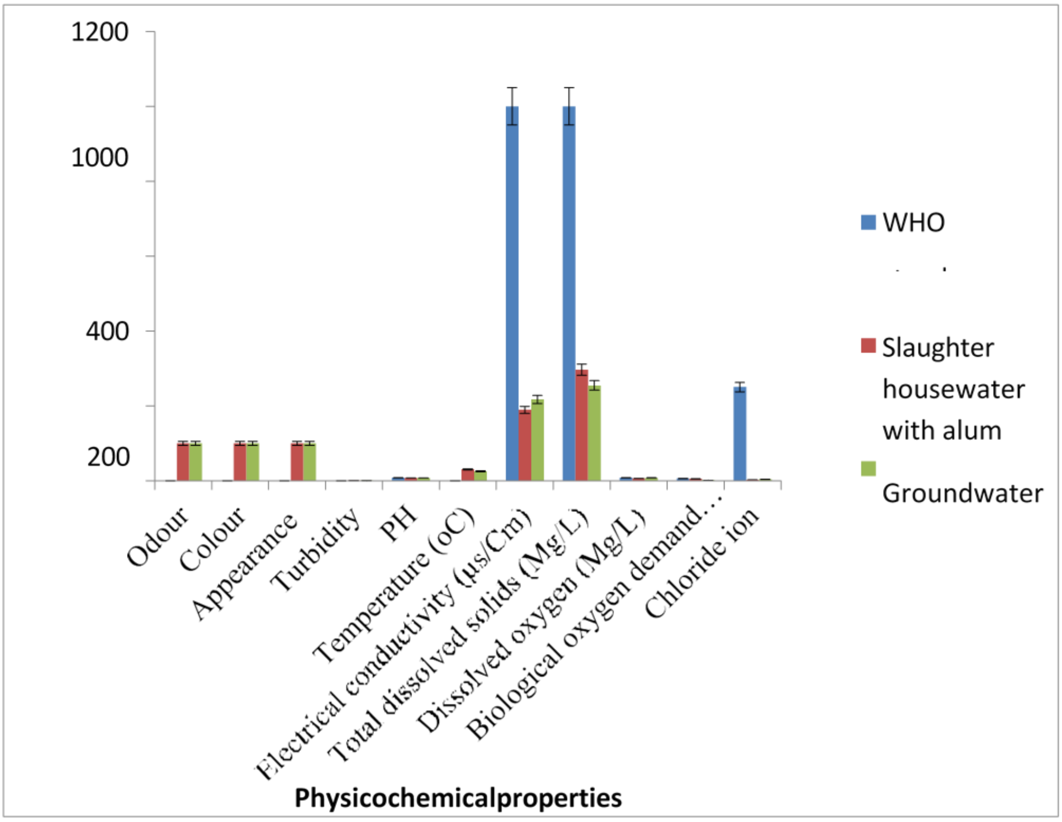

Figure1: Overallphysicochemicalpropertiesaftertreatmentwithalum

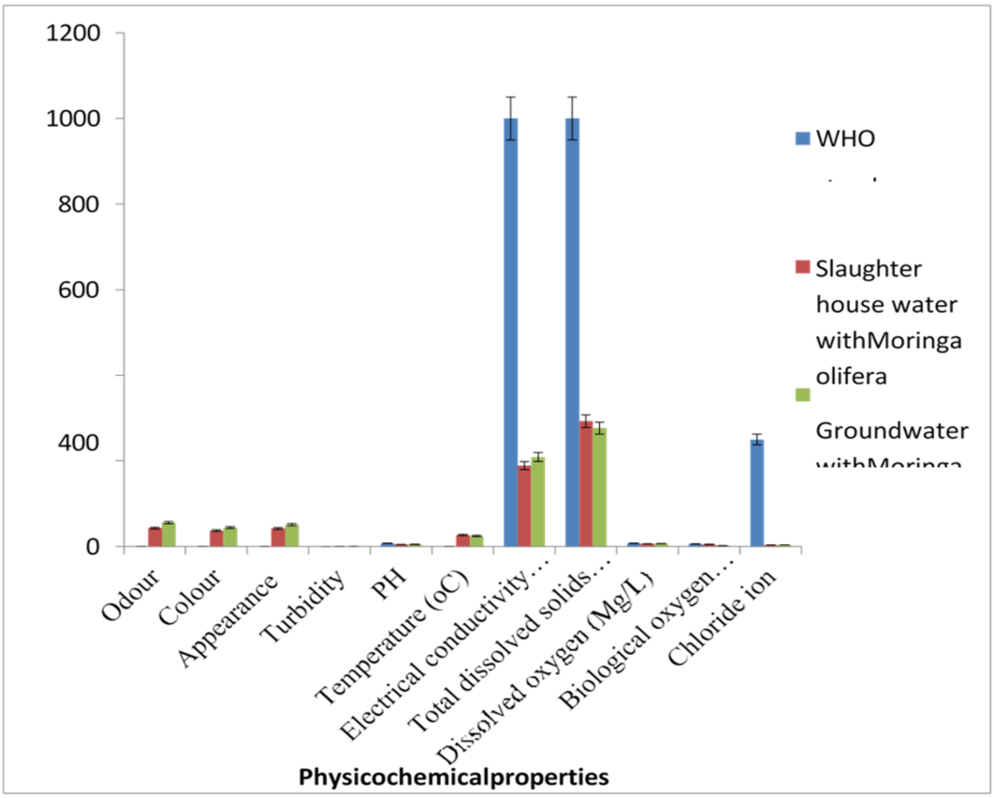

Figure2:Overallphysicochemicalpropertiesaftertreatmentwith*Moringaolifera*

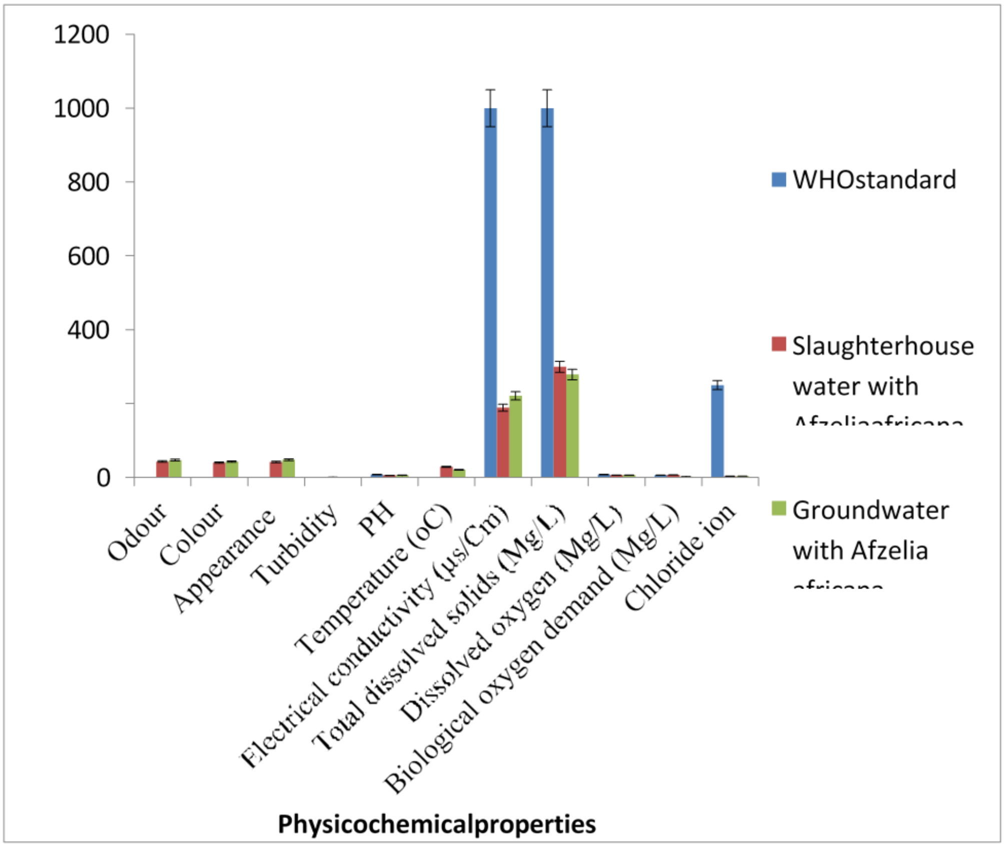

Figure3:Overallphysicochemicalpropertiesaftertreatmentwith*Afzeliaafricana*

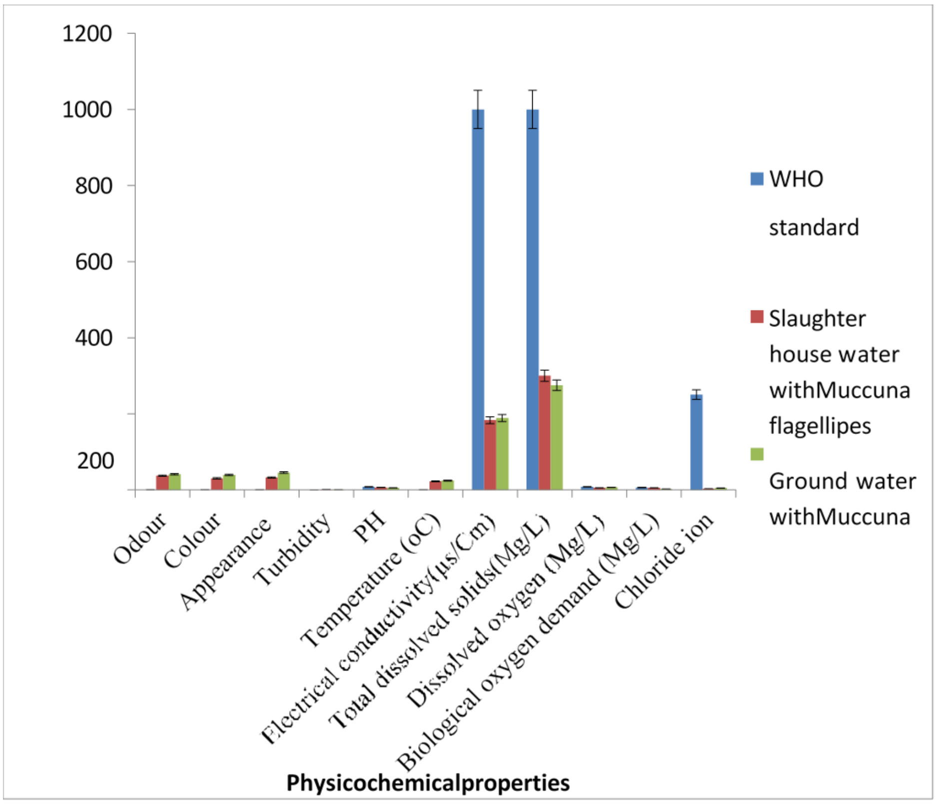

Figure4:Overallphysicochemicalpropertiesaftertreatmentwith*Muccunaflagellipes*

4.3 Bacterial Analysis of the Bio-coagulant, Slaughterhouse wastewater and Groundwater samples Before and After Treatment

The result of the bacterial screening before and after treatment, reveals the presence of the following bacteria; *Escherichia coli, Enterobacter spp., Salmonella spp., Pseudomonas spp., Streptococcus spp., Staphylococcus aureus,* and *Campylobacter jejuni*. The bacteria load for slaughterhouse wastewater beforetreatmentwashighforallthebacteriapresentwithahighercolonialcountagainst*E.coli*forthe different sampling point [upper (4.5x10^{3}cfu), mid (4.0x10^{3}cfu) and down (3.8x10^{3}cfu) slaughterhouse wastewater] with an exception of *Campylobacter jejuni* which was below detection limit (<10). While the colonial count of the bio-coagulant shows that on *Salmonella spp* and *Staphylococcus aureus* were detected at a count of (<50) but others were below detectable limit (<10).

After treatment of slaughterhouse wastewater with the three different bio-coagulants (*M. oleifera*, *A. africana* and *M. flagellipes*) shows that the bacteria load decreased of which *M. oleifera* has the least bacteriacount acrossthedifferentsamplingpointwhichcomparedfavorablytothecontrol followedby

A. africana and *M. flagellipes* having the highest count. Again, *C. jejuni* was below detection limit (<10). Conversely, the bacteria count for groundwater sample before and after treatment was significantlythesamewith exception thetreatment with *M. flagellipes* ofwhich *E.coli* and *C. jejuni*in was higher after treatment (Table 4.6).

Table4.6:Bacterialloadofthebio-coagulant,slaughterhousewastewaterandgroundwater samples before and after treatment with bio-coagulant used and control (alum)

Samples		Bacteria Isolates						
		Escherichia coli	***Enterobacter spp.***	***Salmonella spp.***	***Pseudomonas spp.***	***Streptococcus spp.***	***Staphylococcus aureus***	***Campylobacter jejuni***
BeforeTreatment	USH	$4.5x10^{3}$	$3.7x10^{3}$	$3.8x10^{3}$	$4.1x10^{3}$	$3.3x10^{3}$	$3.2x10^{3}$	<10
	MSH	$4.0x10^{3}$	$3.6x10^{3}$	$3.5x10^{3}$	$3.8x10^{3}$	$3.0x10^{3}$	$3.0x10^{3}$	<10
	DSH	$3.8x10^{3}$	$3.3x10^{3}$	$3.4x10^{3}$	$3.6x10^{3}$	$3.1x10^{3}$	$3..1x10^{3}$	<10
	GW1	$1.0x10^{2}$	<10	$1.0x10^{2}$	<10	<10	<10	<50
	GW2	$1.0x10^{2}$	<10	$1.0x10^{2}$	<10	<10	<10	<50
	GW3	$1.0x10^{2}$	<10	$1.0x10^{2}$	<10	<10	<10	<50
Bio-coagulant	Mo	<10	<10	<50	<10	<10	<50	<10
	Aa	<10	<10	<50	<10	<10	<50	<10
	Mf	<10	<10	<50	<10	<10	<50	<10
Mo	USH	$2.0x10^{2}$	$2.5x10^{2}$	$2.7x10^{2}$	$2.1x10^{2}$	$1.5x10^{2}$	$1.8x10^{2}$	<10
	MSH	$3.0x10^{2}$	$3.1x10^{2}$	$2.9x10^{2}$	$2.7x10^{2}$	$3 x 10^{2}$	$1.5x10^{2}$	<10
	DSH	<10	<10	$3.0x10^{2}$	<10	<10	<10	<10
Aa	USH	$3.5x10^{2}$	$3.0x10^{3}$	$2.9x10^{2}$	$3.1x10^{3}$	$2.6x10^{3}$	$2.0x10^{2}$	<10
	MSH	$3.2x10^{2}$	$2.7x10^{3}$	$2.8x10^{2}$	$2.9x10^{3}$	$3.1x10^{3}$	$1.7x10^{2}$	<10
	DSH	$2.5x10^{2}$	$2.1x10^{2}$	$3.2x10^{2}$	$1.8x10^{2}$	$1.65x 10^{2}$	$1.53x 10^{2}$	<10
Mf	USH	$2.4x10^{3}$	$2.1x10^{3}$	$2.13x 10^{3}$	$2.3x10^{3}$	$2.6x10^{3}$	$2.11x 10^{3}$	<10
	MSH	$2.9x10^{3}$	$3.1x10^{3}$	$3.0x10^{3}$	$2.5x10^{3}$	$2.8x10^{3}$	$2.35x 10^{2}$	<10
	DSH	$2.7x10^{2}$	$2.4x10^{2}$	$3.4x10^{2}$	$2.0x10^{3}$	$1.7x10^{3}$	$2.5x10^{3}$	<10
	COU	$2.1x10^{2}$	$2.5x10^{2}$	$2.3x10^{2}$	$2.1x10^{2}$	$1.5x10^{2}$	$1.8x10^{2}$	<10
Mo	GW1	$1.2x10^{2}$	<10	$1.1x10^{2}$	<10	<10	<10	$x 10^{2}$
	GW2	$1.3x10^{2}$	<10	$1.05x 10^{2}$	<10	<10	<10	$x 10^{2}$
	GW3	$1.2x10^{2}$	<10	$1.2x10^{2}$	<10	<10	<10	$x 10^{2}$
Aa	GW1	$1.4x10^{2}$	<10	$1.5x10^{2}$	<10	<10	<10	$1.2x10^{2}$

	GW2	1.5x10^{2}	<10	1.4x10^{2}	<10	<10	<10	1.5x10^{2}
	GW3	1.6x10^{2}	<10	1.7x10^{2}	<10	<10	<10	1.4x10^{2}
Mf	GW1	1.8x10^{3}	<10	1.8x10^{2}	<10	<10	<10	1.6x10^{2}
	GW2	1.9x10^{3}	<10	1.79x 10^{2}	<10	<10	<10	1.8x10^{3}
	GW3	2.0x10^{2}	<10	1.6x10^{2}	<10	<10	<10	1.9x10^{3}
	COG	1.0x10^{2}	1.0x10^{2}	1.0x10^{2}	1.0x10^{2}	1.0x10^{2}	1.0x10^{2}	1.0x10^{2}

Legend: <10 = Below detection limit, USH = Upper slaughterhouse wastewater, MSH= Mid- slaughterhouse wastewater, DSH=Down-slaughterhousewastewater,COU=Controlforslaughterhousewastewater,COG=Controlforgroundwater GW1-GW3 = Groundwater station 1-3, Mo = *Moringa oleifera*, Aa = *Afzelia africana*Mf = *Muccuna flagellipes*

DISCUSSION

Phytochemical Analysis

The result of phytochemical analysis shows that the aqueous extract of the three different indigenous leguminous plant seed powders (*Moringa. oleifera*, *Afzelia. africana*, and *Muccuna. flagellipes*) have the presence of alkaloids, flavonoids, phenols, tannins, steroids, and anthraquinones. While steroids were only present in *M. oleifera*. This implies that *M. oleifera* has all the phytochemical parameters assessed while *A. Africana* and *M. flagllipes* lack steroids but have the rest phytoconstituents.This result is in line with works of Okwu & Okoro, (2007); Nweze & Nwaform (2014); Ojiako, (2014); Elzein *et al*. (2018) and *Olorunmaiye et al*. (2019).

Physicochemical properties of the water samples before and after treatment Slaughterhouse Wastewater(SHW)

The physicochemical properties of the slaughterhouse wastewater (SHW) before treatment shows that the water was brown in colour and poor in appearance but almost odourless. The turbidity as measured with spectrophotometer is 0.86, pH (6.62) was within WHO standard, while electrical conductivity (195), total dissolved solids (327), dissolved oxygen (4.20) and chloride ion (1.42) were all below WHO standard. Biological oxygen demand (7.59) was above WHO standard. After treatment with alum, which serves as the control, the wastewater becomes colourless, odourless with a better appearance and a significant decreased in turbidity (0.86-0.13), temperature (31-29) and biological oxygen demand (7.59-2.05). The decrease in electrical conductivity (195-187) and total dissolved oxygen (327-305) were not significant while the increase in pH (6.62-7.12) and chloride ion (1.42- 2.14) were statistically significant different at p=0.05.

The result of the physicochemical properties of the slaughterhouse wastewater treated with 15g/300mL stock solution (SS) from the different three plant samples used in this present study at a concentration of 10mL and 20 mL SS revealed asignificant difference in the colour, odour, appearance, turbidity, pH, Temperature, dissolved oxygen, biological oxygen demand and chloride after treatment. The treatment with the best significant increase in colour was *Afzelia africana* (33-43) at 20mL SS, followed by *Moringaoleifera*(33-42)at20mLSSbutinappearance,*M.oleifera*(31-39)wasthebestfollowedby

A.africana(31-37)at20mLSS,although,theobserveddifference was not statistically significant. The decrease in turbidity was least in treatment with *M. oleifera* at (0.86-0.31) at 10mL SS, which agrees withthework(Muyibi*eta*l.2004;Ghebremichael*eta*l.2005;Arnoldsson*etal.*2008;Lea2010;

Subramanium *et al*. 2011; Vikashni *et al.* 2012) as their finding indicated that the turbidity wasreduced from water samples after treatment with *M. oleifera* seed cake. In addition, the decrease in pH and temperature and increase dissolved oxygen were significantly the same across the different treatment. The decrease in pH after treatment below the pH before treatment, shows that the plant materials used were acidic as their pH values were *M. oleifera* (3.82), *Afzelia africana* (4.87), and *Muccuna flagellipes* (5.01).thus, thedecreasein pHaftertreatment does not corroboratewith thework of (Ghebremichael *et al*. 2005; Arnoldsson *et al*. 2008; Alo *et al*. 2012), whose work showed a significant increase in pH after treatment. The reason for the observed difference may be due to the differences in ecological and edaphic factors, which affect the pH of the stock solutions prepared from the study plant samples. Furthermore, the decrease in biological oxygen demand and increase in chloride ion was the same statistically for treatment with *M. oleifera* and *A. africana* at 10mL and 20mL than that of *M. flagellipes* accordingly.

The physicochemical properties of the slaughterhouse wastewater before and after treatment with 30g/300mL stock solution prepared from the three different study samples shows that there was a significant difference in the colour, odour, appearance, turbidity, pH, temperature, dissolved oxygen, biological oxygen demand and chloride ion after treatment, of which the treatment with*M.oleifera*and

A. africana have the highest increase in colour (33-41) at 10mL; (33-40) at20mL and (33-39) at 20mL respectively and appearance, *M. oleifera* (31-44) at 20mL was the best while others were significantly the same. The decrease in turbidity was least in treatment with *M. oleifera* (0.86-0.10) at 10mL and (0.86-0.21) at 20mL, pH was least in *M. oleifera* (6.62-4.76) at 20mL. Also, the decrease in temperature and increase in dissolved oxygen were significantly the same but increase biological oxygen demand and chloride ion were statistically significant in treatment with *M. oleifera* and *A. africana* while, electrical conductivity and total dissolved solids were statistically the same before and after treatment.

Furthermore, physicochemical properties of the slaughterhouse wastewater treated with 10mL and 20mL stock solution prepared from the three different plant samples used reveals an increase in colour and appearance across the treatment of which*Moringa oleifera* and *A. africana* were the highest at (33-40); (33-42) and (33-40); (33-40) at 10mL and 20mL for colour and in appearance at 20mL (45) and (40)respectively. A decreased in turbidity across thedifferent treatment was observed but theleast was seen in *M. oleifera* (0.31) at 20mL. In addition, electrical conductivity and total dissolved solids were statistically the same before and after treatment. The increase in dissolved oxygen and chloride werethesamestatisticallywhiletheincreaseinbiologicaloxygendemandwasmoreintreatmentwith *M. flage llipes* (5.17) and lesser at *M. oleifera* (3.98) both at 20mL.

Ground water (GW)

The physicochemical properties of groundwater before treatment showed that the water was colourless, odourless and excellent appearance. A turbidity of (0.02), pH (7.19), temperature (21), electrical conductivity of (214), total dissolved solid (253), biological oxygen demand (1.56), dissolved oxygen (7.13) and chloride (3.80). after treatment with alum (control), there was no significant difference inthe physicochemical properties. While upon treatment with the different stock solutions (15g/300mL, 30g/300mL and 45g/300mL) prepared from the three different plant materials used for this study at 10mL and 20mL concentrations showed that there was a significant decreased in the different physicochemical properties assessed, which did not compare favorably with the control. There was a change in the colour, odour, appearance and pH, of which the change in colour odour and pH were statistically the same across the different treatment while in appearance, treatment with 10mL *M. oleifera* and *A. africana* were significant the same and better than 20mL of *M. oleifera* and *A. africana* and *M. flagellipes* at 10mL and 20mL. Temperature, electrical conductivity, total dissolved solids, dissolved oxygen, biological oxygen demand and chloride were statistically the same before and after treatment but the turbidity increases after treatment with highest increase observed in treatment with *M.flagellipes*(0.42,0.43and0.42)at10mLand(0.32,0.38and0.39)at20mLrespectively asopposed to the turbidity before treatment (0.02).

Thus, treatment with *M.oleifera* wasbebest bio-coagulants amongtheotherbio-coagulant usedinthis present study and the reason for this may be as result of the high saponin contentas compared to others while the poor coagulating ability seen in *M. flagellipes* may be due to the oily nature of the endocarp which limit its chelating ability [14].

Bacterial Screening of the Bio-coagulant, Slaughterhouse wastewater and Groundwater samples Before and After Treatment

The result of the bacterial screening before and after treatment, reveals the presence of the following bacteria; *Escherichia coli, Enterobacter spp., Salmonella spp., Pseudomonas spp., Streptococcus spp., Staphylococcus aureus,* and *Campylobacter jejuni*. The bacteria load for slaughterhouse wastewater beforetreatmentwashighforallthebacteriapresentwithahighercolonialcountagainst *E.coli*forthe different sampling point [upper ($4.5x10^3$cfu), mid ($4.0x10^3$cfu) and down ($3.8x10^3$cfu) slaughterhouse wastewater] with an exception of *Campylobacter jejuni* which was below detection limit (<10). While the colonial count of the bio-coagulant shows that on *Salmonella spp* and *Staphylococcus aureus* were detected at a count of (<50) but others were below detectable limit (<10).

After treatment of slaughterhouse wastewater with the three different bio-coagulants (*M. oleifera*, *A. africana* and *M. flagellipes*)shows that the bacterialoaddecreased ofwhich treatment with *M. oleifera* has the least bacteria count across the different sampling point with the least colonial count recorded against down-slaughterhouse wastewater, which indicates below detection limit (<10) for all the identified isolates with exception of *Salmonella spp* (3.0×10^2) while that of upper-stream and mid-stream compared favorably to the control. Treatment with *A. africana* shows thatthe least colonial count seen across down-slaughterhouse wastewater which compared well to the control with an exception of *Enterobacter spp., Pseudomonas spp.* and *Streptococcus spp.* Which was still the same before treatment. While treatment with *Muccuna flagellipes* shows that the colonial count for *Escherichiacoli, Enterobacter spp.* and *Salmonella spp.* compared well with the control for down-slaughterhouse wastewater but their colonial count for upper and mid-slaughterhouse wastewater were all higher than the control. Conversely, the bacteria count for groundwater sample before and after treatment was significantlythesamewith exception thetreatment with *M. flagellipes* ofwhich *E.coli* and *C. jejuni*in was higher after treatment, but all compared with control and was still within range WHO allowable bacterial count for domestic water (100-500/ml) of colony-forming units [15-20].

Conclusion

This present study revealed that leguminous plant seed powders from *Moringa oleifera, Afzelia africana* and *Muccuna. flagllipes* used as bio-coagulants for treating wastewater showed possible potential in treating wastewater but not groundwater. *Moringa oleifera* showed the highest potential with evidence of a sharp reduction in turbidity, colour,odour,TDS, BOD,EC and increased in DO, Cl^- after treatment as compared to the untreated wastewater samples. Again *M. oleifera* was also seen as the best in the reduction of total coliforms and some pathogenic bacteria resulting from the wastewater samples.

RECOMMENDATION

- The use of *M.oleifera*shouldbeadoptedinwastewatertreatmentbothlocallyandcommercially.
- Further research should be carried out on other plant materials.

- The use of synthetic coagulants should be discouraged.

References

1. Arnoldsson, E., Bergman, M. & Matsinhe, N. (2008). Assessment of drinking water bark extracts of Moringa oleifera in reducing bacterial load in water. Int J Adv Res 4:124–130

2. Ayekoe, C., Yvette, P., Robert, D. & Lanciné, D. G. (2017). "Combination of coagulation- flocculation and heterogeneous photocatalysis for improving the removal of humic substances in real treated water from Agbô River (Ivory- Coast)". Catalysis Today. 281: 2–13.

3. BiaouS.S.H.,Homengren,M.,Sterck,F.J.&Mohren,G.M.(2011).Stress-DrivenChanges in the Strength of Facilitation on Tree Seedling Establishment in West African Woodlands. Biotropica, 43(1): 23–30

4. Biswas,J.(2015).“AssessmentofphysicochemicalqualityoffoodwastewaterofRaipurarea,”

5. InternationalJournalofEngineeringResearch,3(1):201

6. Boskou, D. (2011). Vegetable oils in food technology. WileyBlackwell; Hoboken, NJ, USA.Olive oil. Pp. 243-2

7. Brain, C. (2021). What is coagulation for water treatment? Retrieved from https://www.wwdmag.com/what-articles/what-coagulation-water-treatment March 3, 2021 Chatterjee,A.(2018).WaterSupplyWasteDisposalandEnvironmentalPollutionEngineering (IncludingOdour,NoiseandAirPollutionanditsControl).7thed.Delhi:Khanna

8. Publishers.Pp67.

9. Chekli, L., Eripret, C., Park, S. H., Tabatabai, S. A. A., Vronska, O., Tamburic, B., Kim, J. H. & Shon, H. K. (2017). "Coagulation performance and floc characteristics of polytitanium tetrachloride (PTC) compared with titanium tetrachloride ($TiCl_4$) and ferric chloride ($FeCl_3$)inalgalturbid water". Separation and Purification Technology. 175: 99–106.

10. Cole, S., Codling, I., Parr, W., Zabel, T., Nature, E. & Heritage, S. N. (1999. Guidelines for ManagingWater Quality Impacts within UK European MarineSites. Research Journal of Recent Sciences 1:30–35.

11. Corrssionpedia (2018). Coagulants. Retrieved from whatisacoagulantdefinitionfrom corrosionpedia September 3, 2021

12. Davis, M. L & David, A. (2008). Introduction to Environmental Engineering. 4thed.NewYork: McGraw-Hill Companies. Pp 70.

13. Davis, M. L. & Masten, S. J. (2016). Principles of Environmental Engineering andScience.NewYork: McGraw-Hill. Pp 10-15.

14. Davis,M.L.(2013).WaterandWastewaterEngineering—DesignPrinciplesandPractice. New York: McGraw-Hill. Pp 35.

15. Déborah, L. V., Pablo, D. A., Jorge, R. & Erick, R. B. (2018). Water Resources. and a propose Integrated use. Proceedings of an internet conference on Phytoremediation and water purification. Pp. 23-35.

16. Dehghani, M. & Alizadeh, M. H. (2016). The effects of the natural coagulant Moringa oleifera and alum in wastewater treatment at the Bandar Abbas Oil Refinery. EnvironmentalHealth Engineering and Management Journal, 3(4):225–230

17. Desta, W. M. & Bote, M. E. (2021). Wastewater treatment using a natural coagulant (Moringa oleifera seeds): optimization through response surface methodology, Heliyon, 7(11): e08451

18. DeZuane,J.(2017).HandbookofDrinkingWaterQuality.2nded.NewYork:JohnWiley&Sons.

19. Pp78-83.

20. Djodjouwin, L., GleleKakai, R. & Sinsin, B. (2011). Caractérisation structurale desformations naturelles enrichies en essences forestières locales: cas des vertisols de la Lama (Benin). Int. J. Biol. Chem. Sci., 5(4): 1628-1638.