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Phytotreatment of Apalara Abaittoir Waste Water Using *Eichhornia crassipes*

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Abstract
Phytotreatment is an approach in which plants are used in the cleanup of contaminated environments. This study, therefore, describes the phytotreatment of abattoir waste water by examining the effectiveness of Apalara abattoir wastewater. Wastewater samples were collected asceptically. The physiochemical results were recorded before and after treatment with water Hyacinth (*Eichhornia crassipes*). Biological Oxygen Demand and Chemical Oxygen Demand reduction range from before and after treatment 130-0.4 and 1240-475 respectively. The results before and after the biological treatment with water hyacinth showed a considerable reduction in the conductivity and pH value of the abattoir wastewater. The pH was reduced to nearly neutral in all cases studied. The reduction in pH favored microbial action to degrade BOD and COD in the wastewater. The reduction of COD and BOD in wastewater samples collected were devoid of dissolved oxygen. There was an increase in the dissolved oxygen from 0.20 to 3.20 after treatment as indicated by the reduction of BOD and COD in the abattoir wastewater. The study has shown that there were increases in protein content and ash content in abattoir wastewater at the end of the proximate analysis.

Keywords: Pytotreatment, Abattoir, BOD, COD, Dissolved Oxygen, *Eichhornia crassipes.*

1. Introduction

Phytotreatment involves plant that aids in the restoration of contaminated ecosystems. *Eichhornia crassipes*, commonly known as water hyacinth is a free-floating perennial aquatic plant. It has been reported to serve as a good nutrient removal and in the pre-treatment of sewage before discharging it to the water bodies (Adeniran, 2009). Phytotreatment is an approach in which plants are used in the cleanup of contaminated environments. It is an emerging technology that promises effective, inexpensive and restoration of contaminated environment. Water hyacinth (*Eichhornia crassipes*) is a free floating (but sometimes rooted) freshwater plant of the family Pontederiaceae that has proven to be a significant economic and ecological burden in many sub-tropical and tropical regions of the world. Water hyacinth is listed as one of the most productive plants on earth and Water hyacinth shows logistic growth as does other floating aquatic weeds. Water hyacinth has invaded freshwater systems in over 50 countries in five continents; it is especially pervasive throughout Southeast Asia, the southeastern United States, central and western Africa, and Central America (Brendonck *et al*., 2003; Lu *et al*., 2007).

Effort has been geared towards curbing the menace of pollution around the world, particularly by the United Nations Organization (United Nations Environmental Program). There are many international conferences and protocols to this effect. The Rio de Janiero conference of 1992 was a major effort towards the collection of previous environmental issues and bringing them to an end. Nevertheless, in many parts of the world, human activities such as animal production still impact negatively on the environment and biodiversity. Some of the consequences of human activities include pollution and transmission of disease by waterborne pathogens. Eutrophication of natural water bodies, accumulation of toxins or recalcitrant chemicals in the soil, destabilization of ecological balance and negative effect on human health (Boadl and Kultunen, 2003).

In many countries, pollution arises from activities in meat production as a result of failure in adheres to good manufacturing practices (GMP) and good hygiene practices (GHP). Consideration hardly gives rise to safety practices during animal transport to the abattoir during slaughter and during dressing. For example, during dressing, the oesophagus of cattle and sheep should be sealed to prevent leakage of animal contents. The ineptitude often leads to contamination from hides, hooves and content of the alimentary track during evisceration and negatively impact on the environment, including microbes in the soil and surface and ground water (Hinton *et al.*, 2000, Laukova *et al.*, 2002).

A specific example of what happens of logging of contaminated water in the soil. In that situation, oxygen becomes less available as an electron acceptor; Archeae (methanogens) may produce excessive methane at a higher rate aerobic methane oxidizing bacteria (methanotrophs) could cope with, thus contributing to the greenhouse effect and global warming. Increase in methane is a concern because it is five times more effective as a greenhouse gas than CO_2 (Madigan *et al*., 2003). Leaching into the ground water is major part of the concern, especially due to the recalcitrant nature of some contaminant (lapygina *et al.*, 2002) The process of adsorption and trapping by fine sanding material clays and organic matter can remove pathogenic organisms and some dissolved organic matter during passage of polluting matter, thus reducing the microbial load.

However, if there is a too high departure of condition forms normal cybeyond the carrying capacity of the natural process, diversity of autochthonous species could diminish while counts of individual species that are able to survive may increase with the possibility of the great consequences of ground water (Atlas and Bartha, 1998; Lapygina *et al.*,2002).

Different methods of waste treatment have been developed due to reasons of public health and conversation which result in the destruction of pathogens and the mineralization of organic components of sewage prior to discharge. Anaerobic wastewater treatment using granular sludge reactor is one of such methods (Liu *et al.*, 2002; Boadl and Kuitunen, 2003).

However, developing countries like Nigeria, discharge of untreated wastes into the environment which is still a problem despite the establishment of the Federal Environment Protection Agency (FEPA) (Adeyemo, 2003). Better inspection of abattoir and strict enforcement of the law are needed to be able to reduce environmental contamination and related diseases, especially zoonotic diseases attempts to control the hygiene of slaughter house which should include visual assessment of the premises and those involved which are visibly dirty or are affected by diseases should not be allowed to slaughter (Amisu *et al.*, 2003).

The consequences of infection by pathogens originating from animal waste can range from temporary morbidity or mortality especially in high risk individuals. Due to the difficulties in quantifying pathogen indicator of feacal pollution, including coliform bacteria and fecal coliform. *Escherichia coli* or *Enterococci* have been monitored in lieu of other pathogens for more than 100years. This study, therefore, describes the phytotreatment of abattoir waste water by testing water hyacinth on the waste.

2. Materials and Methods

2.1 Sampling Area and Collation

Wastewater was collected from the Mandate Market (Apalara, Abattior), Ilorin using a sterile container. The container was used aseptically to draw part of the waste water running off the drainage system just as it leaves the slaughter pavement and was transported to the microbiology laboratory immediately. This was carried out according to the methods described by Adesemoye *et al.*, (2006) using the hyacinth plant.

2.2 Determination of Physicochemical Properties

2.2.1 $_P$H and Temperature Determination

The $_P$H (Hanna H19024 microcomputer) was calibrated with two buffer standard solutions ($_P$H 4 Buffer and $_P$H 9 Buffer). After that, the $_P$H reading of the sample was taken on the spot as well as the temperature.

2.2.2 Total Suspended Solid (TSS)

100ml of each water was filtered through a pre-weighed filter paper. The paper was dried at 103-105^{0}C. TSS was determined by using the following formula (Anon, 1992).

$$TSS\ (mgl^{-1}) = \frac{final\ mass - initial\ mass}{Amount\ of\ sampls\ taken}\ x\ 100 \quad (1)$$

2.2.3 Total Dissolved Solid (TDS)

This was by the evaporation method. Evaporating dish was weighed and later 100ml of the water sample introduced into weighed dish and dried in an oven operated at 103^{0}C for one hour to a constant weight. After drying, it was transferred to a desiccator and was left cool for one hour. The dish was finally weighed with its content. The difference in mass gives a measure of the total dissolved solids of a sample (Hach Water Analysis Hand Book, 1983)

2.2.4. Biological Oxygen Demand (BOD)

The BOD was determined using Winkler Titration Method. The water sample was collected in the BOD bottle and incubated at 20^0C in the dark for 5days. The BOD on day five was determined using the same procedure for DO above. The mass of oxygen obtained on day five was subtracted from the mass of oxygen on day 1 to determine the BOD (mg/l) using the formula (Ademoroti 1996).

$$BOD\ (mgl^{-1}) = DO_1 - DO_5 \qquad (2)$$

2.2.5 Chemical Oxygen Demand COD)

Titrimetric Method was employed in the determination of COD. A 10ml of 0.123M $K_2Cr_2O_7$ was added to 20ml of the water sample using a pipette in a refluxing flask. Glass beads or anti bumping chips were added. Then 30ml of concentrated H_2SO_4 was added slowly and with gentle swirling. The flask was connected to the condenser and refluxed for 2h. After that, the flask was cooled and the condenser washed with distilled water into the flask and diluted to about 150ml. The excess dichromate was titrated with 0.05M ferrous ammonium sulphate (FAS) using 2 drops of ferrion as an indicator. A blank mixture was prepared and treated using the same procedure (Ademoroti, 1996)

$$COD(mgl^{-1}) = \frac{V_b - V_s\ xMx\ 1600}{ML\ sample} \qquad (3)$$

$Where;\ Vb\ = Ml\ FAS\ used\ for\ blank, Vs = ML\ FAS\ used\ for\ sample, M = molarity\ of\ FAS.$

2.3 Biotreatment Using Water Hyacinth

The waste from a slaughter house is categorized as organic waste which is high in protein, fats and starches. This waste is a potential source of pollutant. Slaughterhouse waste can be treated biologically. One of the biological treatments is the use of water hyacinth *(Eichhornia crassipes)* which is known to have the ability to remove organic and inorganic compounds and heavy metals.

Water hyacinth plants *(Eichhornia crassipes)* were collected from one of the canals in Lagos. It was then rinsed off properly to remove the dirt and the plant was transferred into a large bowl containing water. After some days in which the plants would have adapted to a new climate, then, the plants were extracted and dried in the incubator for 24 hours. Proximate analysis was carried out on plants, to estimate nitrogen (N), potassium (K), magnesium (Mg), iron (Fe), fats, carbohydrate, protein, ash content and the moisture, which was done before and after, introducing the plants into the wastewater and also, monitored for biodegradation processes.

2.4 Determination of Proximate Composition

The proximate composition of the water hyacinth plant, that is moisture content, fat content, ash content, protein content, as well as the crude fiber was determined according to (A.O.A.C, 1990).

2.4.1 Moisture Content Composition

$$\% \, \boldsymbol{Moisture\ content} = \frac{\boldsymbol{W_1 - W_2}}{\boldsymbol{W_1 - W_0}} \, \boldsymbol{x\ 100} \qquad \textbf{(4)}$$

Where,

$W0 = initial\ weight\ of\ the\ sample.$

$W1 = Weight\ (g)\ of\ the\ dish\ and\ the\ lid.$

$W2 = Weight\ (g)\ of\ the\ dish, lid\ and\ the\ sample.$

$W1 - W2 = Weight\ of\ sample\ prepared\ for\ drying$

2.5 Determination of Protein

About 2g of the sample was weighed into a digestion tube and 15mls of concentrated H2SO4 was added to dissolve the sample. Kedah tablets were added to start up the digestion process in a fume cupboard preset at 410°C for 45 minutes until it gives a clear solution. 75 ml of distilled water was added to prevent it from solidifying after digestion.

The tube was placed in a distilling unit and 50 mls of 40% NaOH dispensed into the diluted solution, and the digested distillate into 25 mls of 40% boric acid for 5 minutes. The distillate was titrated against 0.47 Hcl until the first grey colour was seen. A blank was first run and the titre value was recorded (A.O.A.C, 1990).

$$\%\text{Total Nitrogen} = \frac{Titre\ value\ x\ 14.01\ x\ 0.47}{Weight\ of\ sample\ x\ 100}$$

(5)

$$\%\ Protein\ =$$

$$Total\ nitrogen\ x\ conversion\ factor$$

(6)

$$Molecular\ weight\ of\ Nitrogen$$
$$=\ 14.0, Molarity\ of\ Hcl$$
$$=\ 0.47, Conversion\ factor$$
$$=\ 6.25$$

2.6 Crude Fat Determination

Crude fat was carried out using the method of AOAC, (1990) by Cleaning and weighing a dried thimble. It was recorded as (W1) and 5g oven dried sample was added and re-weighed as (W2). Round bottom flask was filled with petroleum (ether 40-60)^{0}C up to ¾ of the flask. Soxhlet extractor was fixed with a reflux condenser to adjust the heat sources so that the solvent boils gently, the samples were put inside the thimble and inserted into the soxhlet apparatus and extraction under reflux was carried out with petroleum ether for 6 hours.

After the barrel of the extractor is empty, the condenser was then removed and the thimble was removed, taken into the oven at 100^{0}C for 1 hour and later cooled in the desecrator. It was then weighed as (W3).

Calculation: % Fat =

$$\frac{\text{Weight loss of sample (extracted fat) x 100}}{\text{Original weight of sample}}$$

(7)

$$= \frac{W_2 - W_3}{W_2 - W_1}\ x\ 100$$

2.7 Crude Fibre Determination

Two grams (2g) of the sample were weighed into the fibre flask and 100ml of 0.225 H_2SO4 was dissolved into solution. The mixture was heated under efflux for 1 hour using a heating mantle; the hot mixture would be filtered through a filter cloth. The filtrate obtained was discarded and the residue was poured into the flask to which 100mls of 0.313 NaOH was added and re-heated under reflux for another 1 hr. The mixture was filtered through a sieve cloth and 100mls of acetone was added to dissolve any organic constituent present. The residue was washed with 50mls of hot water twice on the sieve cloth before it was finally transferred into the crucible. The crucible and the residue was dried in an oven at 150^0C, cooled in a desiccator and weighed (W1). The weighed sample was then transferred to the muffle furnace for ashing at 5500c for 4hrs. The crucible containing the ashed sample was cooled and weighed (W2).

$$\%\ \boldsymbol{crude\ fibre} = \frac{\boldsymbol{W_1 - W_2}}{\boldsymbol{Weight\ of\ the\ sample}}\ \boldsymbol{x\ 100}$$

(8)

2.8 Carbohydrate Fibre Determination

Carbohydrate content determination will be calculated as;

$$\%carbohydrate\ =\ 100\% - \%\ (protein + crude\ fat\ +\ ash\ +\ moisture\ +\ crude\ fibre)\ contents$$

(9)

2.8 Mineral Content Determination

The samples were pulverized, weighed and placed in the muffle furnace at 550^0C for ashing. The ash was dissolved in 100cm3 HCl (10%) solution which was subsequently used in the mineral content determination. The determinations were carried out using the atomic absorption spectrophotometer-radiation of each bulk 20 A model. Its hollow cathode lamp supplied resonance line radiation of each mineral. Standard calibrations were employed during analysis. Nitrogen content was determined using Kedah method as described above for protein determination (AOAC, 1990).

3. Results and Discussion

3.1 Results

The result obtained from the analysis of abattoir wastewater as shown in Table 1 represents the physiochemical properties of the source water and the abattoir wastewater (before and after treatment) gotten from mandate market. Table 2 represents the analysis of water hyacinth (before and after use) there was a significant reduction ($p<0.05$) in all the pollutants with the passage of time.

Table 1: Physio-chemical properties of abattoir wastewater from Mandate market.

Parameters	Source water	Abattoir wastewater (before treatment)	Abattoir wastewater final (after treatment)
Temperature $T^{O}C$	27.8	28.4	28.0
Colour	Colourless	Reddish brown	light brown
Odour	Odourless	Dung	Fair
pH	7.07	7.19	6.98
Conductivity	642.23	887	655.30
Dissolved oxygen mg/l	4.5	0.2	3.20
Biological Oxygen Demand (BOD) mg/l	54.5	130	0.4
Chemical Oxygen Demand (COD) mg/l	700	1240	475
Total Suspended Solid (TSS) mg/l	76.50	2266.82	472
Total Dissolved Solid (TDS) mg/l	1350.20	880	820.52
Total Solid (TS)	1426.70	3116.82	1292.52

mg/l			
Chloride cl^-	8	15	12
Sulphate So_4^-	15	28	22.23

Table 2: Analysis of Water hyacinth (Before and After Use)

Time (hrs)	Moisture content (%)	Protein (%)	Ash (%)	Fat (%)	Fibre (%)	Carbohydrate (%)	Iron (Fe) ppm	Magnesium (Mg) ppm	Phosphate (PO_4^{2-}) mg/l	Nitrogen (N) ml/g
Before										
24	**93.06**	**3.43**	**1.00**	**0.31**	**1.20**	**1.00**	**1.40**	**1.79**	**0.39**	**0.54**
72	**93.24**	**3.39**	**1.02**	**0.31**	**1.24**	**0.83**	**1.42**	**1.81**	**0.41**	**0.5490**
144	**92.89**	**3.47**	**0.98**	**0.32**	**1.17**	**1.15**	**1.39**	**1.78**	**0.38**	**0.5483**
After										
24	**93.06**	**3.43**	**1.00**	**0.31**	**1.20**	**1.00**	**1.398**	**1.792**	**0.0390**	**0.5488**
72	**85.28**	**4.33**	**2.05**	**0.33**	**1.57**	**6.44**	**1.572**	**1.901**	**0.0422**	**0.6928**
144	**80.29**	**5.31**	**3.10**	**0.31**	**1.85**	**8.64**	**1.789**	**2.103**	**0.0501**	**0.8496**

3.2 Discussion

The feasibility of water hyacinth to treat the wastewater from a sample which was carried out in 24hours indicate that water hyacinth is very efficient in reducing heavy metals in wastewater. The results before and after the biological treatment with water hyacinth showed a considerable reduction in the conductivity and pH of the wastewater. The pH was reduced to nearly neutral in all cases studied. It can be interpreted that the reduction in pH and conductivity might be due to absorption of pollutants by plants. The reduction in pH favored microbial action to degrade Biological Oxygen Demand and Chemical Oxygen Demand in the wastewater.

The Reduction of COD and BOD in wastewater samples collected were devoid of dissolved oxygen. There was an increase in the dissolved oxygen after treatment as indicated by the reduction of BOD and COD in the wastewater. According to Reddy, (1981) the presence of plants in wastewater can deplete dissolved CO_2 during the period of high photosynthetic activity. The BOD and COD reduction ranging from 0.4 - 475 is very encouraging performance for any kind of industrial waste after only 144 hours of treatment. Tripathi and Shukla, (1991) reported a 96.9 % reduction in BOD using water hyacinth and algae for sewage wastewater.

An effect on Plant Growth was not affected to any great extent, but some yellowish and necrotic spots appeared on the leaves. The anatomy of plants showed some significant ($p < 0.05$) reduction in different cell sizes in various parts of the plant (Mahmood *et al*., 2005). While studying the uptake of some heavy metals by water hyacinth, Ingole and Bhole (2003) indicated that at lower concentrations (5 mg/l) of heavy metals, the plant growth was normal and removal efficiency was greater.

At higher concentrations greater than (10 mg/l), the plant started wilting and removal efficiency was reduced. Statistical Significance of the time period of the Biotreatment has an effect on the absorption of various pollutants by water hyacinth. There was a significant ($p<0.05$) reduction in all the pollutants with the passage of time. Absorption of Heavy Metals Water hyacinth has tremendous potential to remove heavy metals from a growth medium, initially the absorption was greater but it decreased with the passage of time. Studies concerning freshwater resources decontamination are extensive and some freshwater plants have been found to be efficient in accumulation of heavy metals according to Mahmood *et al*., (2005), among which water hyacinth is the most efficient in its prolific growth in the polluted environments. It has not been long since water hyacinth was used commercially as a wastewater cleaning source.

Conclusion

The study has shown that there is an increase in protein content and ash content in abattoir wastewater at the end of the proximate analysis. The lipid content in the wastewater remains the same, but the carbohydrate and moisture content reduces which means that the minerals in water are decreasing respectively. Water hyacinth exhibited effectiveness in reduction of the abattoir. Water hyacinth showed signs of wilting, as a result of its adaptation to the toxic minerals of the wastewater. Water hyacinth could serve as plant of choice for phytotreatment of abattoir waste.

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