Modelling the effects of Ordinary and de-oiled Moringa Oleifera Seed in the treatment of Bacteriologically loaded Abattoir Waste Water

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ABSTRACT- Abattoir water treatment is a complex process that requires highly skilled labour, yet it’s negative environmental impact cannot be overlooked. In this research, effort is made to simplify this process by developing models that can be applied in handling the bacteriological loaded abattoir waste water treatment with the use of ordinary and deoiled Moringa Oleifera seed. The Moringa extraction involved soxhlet method with hexane as the solvent. The cake and powder obtained were used in the treatment in two replication respectively, the mean values from the raw data was analysed using mini tab statistical software and linear and multiple linear regression models were developed. Abattoir wastewater samples were collected in a cleaned and rinsed jeri can for laboratory analysis. Either forms of the bio-coagulant were used at 10, 20, 30, 40 and 50% concentrations for the treatment. Dosage was also varied from 0, 0.8, 0.9, 1.0, 1.1, 1.2, 1.3, 1.4 and 1.5 mg/l for the respective forms of Moringa. Analysis of variance ANOVA was conducted at all levels of significance and R² values obtained from the entire analysis revealed the most significant performance of 0.000 at 30% concentration and the R² values of 96% and hence the most reliable and generally applicable model is obtained using de-oiled Moringa for the abattoir wastewater treatment.

Key words – Abattoir, waste water, modelling, extraction, Moringa.

1. INTRODUCTION

A model is a system similar to the actual size or version, whose operation can be used to predict the characterization of the prototype (Leton, 2005). Models are broadly classified into physical and mathematical. Physical model refers to situation where analogue technology and principles of similitude are applied to laboratory small scale models. Mathematical models are those that use mathematical statements to represent a system (Agunwamba, 2007).

The use of models enables the understanding of processes, predicts and simulates treatment process. It also controls, monitors and optimises water treatment plants (Banadda et al., 2011). A good model is one that gives a better understanding of the complicated engineering, biological and chemical fundamentals and is essential for design process and dynamic prediction.

There is a growing need for engineering models especially in the face of the present environmental challenges that are threatening human health and existence. Although abattoir operation are beneficial to man, as it provide meat for human consumption, large volume of waste water generated from abattoir and discharged into receiving water bodies untreated is a major source of pollution of both surface and ground water (Adasemoye et al., 2006; Meadows 1995).

Abattoir waste water can introduce enteric pathogens and excess nutrients into water and contaminate groundwater (Nafarnda et al., 2005). In developing countries, the operation of abattoir is responsible for generating foul odour and anaesthetic presentation (Akpan, 2004). Waste water treatment is carried out principally to eliminate or reduce the pathogenic organisms, and to diminish the oxygen depleting ability of micro-organisms in waste water (Bassehervre, 1996).

The conventional method of waste water treatment involves various water clarification processes. These methods include flocculation, coagulation, sedimentation and disinfection using chemical coagulants such as aluminium sulphate and chlorine to disinfect, which are usually less available and expensive, more so, the dosage and technique involved are too cumbersome for use in most rural areas in addition to its adverse health hazard. The chemical coagulant has been identified to be responsible for transmitting Alzheimers disease with residual aluminium in treated water and it produces
large volume of sludge. (Ndabigengesere and Narasiah, 1998). The use of synthetic coagulants such as Aluminium Sulphate has so far been dominant in waste water treatment processes worldwide (Bratby 1980) but the health hazard associated with this prompted the use of ferric salt which has not addressed this problem, hence the growing effort geared towards providing an environmentally friendly and natural alternative.

Moringa Oleifera also referred to as horseradish tree which belong to the family of Moringacae is widely cultivated in Pakistan, Bangaladash, India and in northern part of Nigeria (Anwar et al., 2007). This tree serves variety of purposes, viz. as vegetable soup, medicinal, cosmetic and as a drink (tea). Moringa Oleifera is found to be a good substitute that is environmentally friendly and locally available substance that has demonstrated great ability as bio coagulant and recently as a disinfectant (M.Scholz 2010; Bichi et al., 2012.) This substance has been used in different forms (extract, powder and seed) to treat waste water and has been found to be non toxic (Bergamasco et al., 2012; Mataka et al., 2006; Grabrow et el, 1985 and Narasiah et al.,1998)

II. METHODOLOGY

2.1 Materials selection and Preparation of Samples

2.1.1 Moringa Seed Sampling and Preparation

Moringa seeds in their matured dry cobs were plugged from Moringa Oleifera plants. The cobs were opened to obtain the unshelled seeds. The seeds were then dried and subsequently grounded with mortar and pestle to fine powder. The powder was sieved through 0.5 – 0. 6mm diameter sieve. Powdered Moringa was shared into two portions for oil extraction and for use as in its ordinary state in the laboratory.

The Moringa Oleifera seed is shown in Plate 1 and the shelled seeds are also displayed on Plate 2 in preparation for the analysis.

2.1.2 Waste Water Samples Collection and Preparation

The waste water samples were collected at Markurdi bridge river side of Wadata abattoir using composite sampling method. 25 litres Jeri-can was used for the samples collection. The can was washed with liquid detergent, rinsed with distilled water and sterilized with antisepsic each time the samples were collected; a filter material was placed over a funnel inserted in the can which served as a screening process to limit the passage of debris mater. The samples were immediately transported to the laboratory of the Benue state Water board where analysis were carried out according to standard procedure described by (Edmund 1992).

![Plate 1: Showing Moringa Oleifera Unshelled Seeds](image1)

Plate 1: Showing Moringa Oleifera Unshelled Seeds

![Plate 2: Showing Moringa Oleifera seed](image2)

Plate 2: Showing Moringa Oleifera seed

2.2 Experimental Procedure

2.2.1 Moringa Oil Extraction

Moringa Oleifera seed was grounded in a domestic blender and sieved. Hexane solvent was introduced and stirred in weighed round bottom flask and a condenser is then fitted in the electro- thermal Soxhlet extractor and the oil extraction was then executed.

2.2.2 Laboratory Analysis

Six Jars containing various Moringa levels in a beaker with 500mls of the abattoir waste water was tested in parallel. The Flocculator was operated at varying speed from 0 to 450rpm and the dosage applied in this work was from 0, 0.8, 0.9, 1.0, 1.1, 1.2, 1.3, 1.4 and 1.5 respectively. After the test, 25mls was removed from each beaker using a graduated pipette for the various tests. The test was carried out before and after the addition of ordinary and de-oiled Moringa respectively.
Nutrient agar was used as a medium for isolation. The medium was prepared and sterilized at 121°C for 15 minutes. The prepared media dispensed aseptically into sterile Petri dishes and left on the bench to solidify slowly at room temperature. The medium was introduced into the water samples in the 15 bottles for each set of the experiment after incubating for 24 hours, the representative colonies were counted through the microscope and recorded. The experiment was repeated for all the waste water samples.

Dissolve oxygen DO (i) was determined using the oxygen meter model 71 by HACK. The probe was immersed into distilled water to adjust the reading. Subsequently the probe was immersed in the Abattoir wastewater and the reading recorded. The DOx(x) was also determined in similar manner. Subsequently the BOD was obtained by calculation.

Plate 3: Showing a laboratory set where flocculated water settles

2.3 Statistical analysis

The data collected from the laboratory analysis in two replications were processed by determining the mean values of each of the parameters investigated to prepare same for the software analysis. Regression analysis was used on the obtained experimental data using Mini Tab software package and test of significance was conducted. The relationship between treatment and parameters, given by: 

\[ Y = b_0 + b_1(x) + \varepsilon \]

Where \( b_0 \) and \( b_1 \) are the regression coefficients, \( Y \) = dependent variable, \( \varepsilon \) = error. The levels of significance were also obtained from the Analysis of variance (ANOVA). Graphs of the predictive model value versus the investigated parameters were then plotted to show the trend through the treatment. Further to the Simple linear regression was multiple regression analysis to determine the inter parameter interaction to show generally applicable models for typical abattoir waste water treatment.

II. RESULTS AND DISCUSSION

3.1 Developed Linear Models

When the raw Data was subjected to analysis by the use of Mini tab statistical soft ware and the plotting done by excel, the analysis has revealed the action of Moringa in raising the level of dissolved oxygen significantly with the use of MCS and the R\(^2\) of 98.9% was recorded, and 97.7% for MPS at 10% concentration. Dissolved oxygen (1) and (2) of the abattoir waste water using MPS and MCS displayed similar response to the treatment as both of these kept increasing slightly as seen in figure 1. This increase in dissolved oxygen indicates reduction in the level of pollution in the abattoir waste water as the Moringa dosage increased from 0 – 1.5mg/l. The significant performance of the MCS could be as a result of ease in the adsorption of suspended matter enhanced by the absence of oil in the Moringa thus clarifying the waste water by reducing the organic matter and re-oxygenating it. A direct correlation is established between the rising level of dissolved oxygen and reduction in the BOD of abattoir waste water. This is observed when oil free Moringa was introduced for treatment, at 0.003 level of significance which gave rise to the value of R\(^2\) of 91.1%. The consequence of the increase in DO\(_1\) and DO\(_2\) is the reduction of the BOD which has dropped drastically as indicated in Fig. 6.

Dosage variation at this concentration had significant effect in the bacteria removal with an R\(^2\) of 99%. This shows how Moringa cake solution can subdue the coliform bacteria resident in the abattoir waste. Low performance is however recorded when ordinary Moringa was used, it significantly reduced the initially micro-polluted abattoir waste especially with respect to the use of MCS, as shown in figure 6 has significantly reduced the pathogen of the polluted water. This anti microbial activity can be attributed to the action of polypeptides which are able to aggregate the bacteria, forming essential enzymes which after flocculation exterminated both fungi and bacteria, a finding that agrees with that of Eilert et al. 1981; Suarez et al. 2003.

At 20% concentration, the regression equation obtained upon analysing the effect of dosage on waste water revealed an increase amount of dissolved oxygen (DO\(_i\)) with 0.005 level of significance from the analysis of variance. Whereas fairly significant response was recorded with the use of MCS at this concentration with the R\(^2\) of 69.4%, with use of MPS, 94.5% was recorded. for DO\(_{i1}\) is found to have significant effect on dissolved oxygen DO\(_{i1}\). This evidently show the superiority in the ability of MCS introducing greater dissolved oxygen over MPS thus improving the quality of the waste water by reducing its BOD. The trend is expressed in figure 2. The 20% concentration has also displayed an improvement in its
performance. This is due to the spread and increase of contact of the waste water with the de-oiled Moringa. Also with 30% concentration, the results of the analysis revealed a high level of significance in the effect of dosage as DO increases, using Moringa in either form. However, MCS has demonstrated more efficiency where 0.001 and 0.000 levels of significance were recorded in DO$_1$ & DO$_2$ respectively. This is in comparison with the 0.030 and 0.001 recorded when MPS was used. From the result of the analysis, the model equations of DO$_1$ (mg/l) = 4.19 + 0.698 (dosage) and DO$_2$ (mg/l) = 2.27 + 1.93 (dosage) using MPS was obtained, while with MCS, equations of DO$_1$ (mg/l) = 1365 - 1017 (dosage) and DO$_2$ (mg/l) = 3.98 + 1.25 (dosage) was equally developed, the trend is shown in fig 3. This increased amount of dissolved oxygen is responsible for the improved quality of the waste water hence creating a conducive environment for the sustenance of the aquatic beings. The ANOVA revealed high levels of significance as either forms of Moringa was used at 40% concentration, except in the case of DO$_1$ which has the P-value of 0.069 using MPS. DO$_2$ (MPS) responded at 0.000, DO$_1$ (MCS) 0.003; DO$_2$ (MCS) 0.000 levels of significance respectively. The high reduction in the organic matter especially with the action of MCS which adsorbed most of the dissolved and suspended solids was enhanced by the increase concentration of the bio coagulant. As seen in figure 4. The results at 50% concentration of the analysis revealed adequate dissolution of the oxygen in the waste water in response to the MCS and MPS dosage. This development gave rise to the values of R$^2$ recorded with corresponding levels of significance of 0.015 and 0.006 DO$_1$ (1) for MPS and MCS while with DO$_2$ (5), 0.000 was obtained with the use of either forms of Moringa. Increased amount of dissolved oxygen has been maintained through the treatment process. This is seen in figure 5.

A direct correlation is established between the rising level dissolved oxygen and reduction in the BOD of abattoir waste water. This is significantly observed when oil free Moringa was introduced for treatment at 0.003 level of significance. This is what gave rise to the R$^2$ of 91.1%. The consequence of the
increase in DO (i) and DO (ii) resulted in the reduction in the BOD value which dropped drastically as indicated in Figure 6. This great improvement in the waste water quality is also time dependent as it takes increases in values of dissolved oxygen for the BOD removal to be achieved.

In response to the increase in DO, due to the use of MPS and MCS at 20% concentration, there was a significant reduction in the BOD of the waste water at 0.000 and 0.002 levels of significance with 84.7% and 76.8% R² values, using the respective forms of the bio-coagulant. The model equation of BOD (mg/l) = 151 – 63.9mg/l (dosage), BOD (mg/l) = 130 – 64.7 (dosage) were obtained respectively. Consequent upon the increase values of DO₁ and DO₂ with the use of MPS and MCS, it resulted in steady reduction in the BOD of both waste water samples analysed, with better reduction using MCS. This has significantly reduced the odour and enabled a better survival of the aquatic being due to improved quality of the waste water. The trend is shown in figure 7.

A direct correlation between the increase in amount of dissolved oxygen and the reduction in the BOD of the waste water has been consistent in this research. This is seen in the respective R² values obtained and hence the level of significance using both forms of Moringa Oleifera as 88% and 78% efficiency was recorded with 0.000 and 0.002 levels of significance using 30% concentration of MPS and MCS respectively. The removal of the organic matter loaded in the waste water by adsorption and sedimentation was effected more by de-oiled Moringa as in figure 8.

The reduction of BOD in the treated waste water remains significant with R² values of 80.4% due to the use of 40% MPS. This is a better performance when compared with the 72.3% with MCS; the trend is shown in figure 9 where the plots are super imposed on each other. The effect of this bio-coagulant especially the MCS in handling the organic load in the waste water is hereby displayed. BOD of the waste water was marginally affected by the dosage at 50% concentration of MPS and MCS of 0.000 levels of significance respectively as shown in fig 10.

Dosage variation at this concentration had significant effect in the elimination of the bacteria with an R² value of 99%. This gives a clear ability of Moringa to subdue the coliform bacteria resident in the abattoir waste. Weak performance was however recorded when ordinary Moringa was used. Moringa has significantly reduced the initially micro-polluted abattoir waste especially with the use of MCS as can be seen in figure 6, which led to growth inhibition and extermination of bacteria.

The analysis showed a more significant effect of dosage on waste water samples at 20% concentration, with the use of MPS than MCS with 0.000 and 0.003 level of significance and R² values of 0.899 and 0.733 respectively. When these samples were subjected to the treatment process by applying 0 to 1.5mg/l of MPS and MCS the TCC values reduced drastically as shown in figure 7. The strength of its bacterial destruction was enhanced due to ingredient and the micro organism in the abattoir waste.

The increased MPS concentration has resulted in 0.000 level of significance, which is slightly better than the 0.004 recorded with the use of MCS at 30% concentration as plotted in figure 8. The increase in the Moringa powder concentration favours the elimination of the bacteria load in the abattoir waste water.

At 40% Moringa concentration, the Bacteria count in the waste water was significantly reduced especially with the use of deoiled Moringa with the P-value of 0.002, this is in comparison with the 0.018 obtained using ordinary Moringa. Even at control level, sufficient level of reduction was realised and was further removed with the introduction of the bio coagulant. This evidently shows how that this substance possesses the characteristics of a disinfectant especially in the absence of oil as seen in figure 9.

When 50% concentration was used, Coliform bacteria show a significant reduction of 0.000 P-values with the use of either form of the bio coagulant. It resulted in the removal of the coliform from the abattoir waste water. Fig. 10, both of which were virtually eliminated with the maximum dosage of 1.5mg/l. The bacterial response to this treatment using the Moringa was highly significant and it rendered the waste water safe for disposal. The ability of the bio coagulant to absorb and sediment the bacteria has been demonstrated.

![Bacteriological Parameters vs Dosage](https://www.ijettjournal.org)
percentage concentrations stipulated in the experiment. Consequently, Linear multiple regression models were developed. This shows the interactions between the entire waste water composition and the treatment substance used and models applicable to bacteriological contaminated abattoir waste water emerged.

At 10% concentration of the MPS, the regression model equation obtained is:

\[
\text{Dosage (mg/l) = 1.57 - 0.00325BOD - 0.000692T/Col}
\]

The correlation coefficients revealed a highly responsive interaction with 93.6% \( R^2 \) value and a very high level of significance of \( p = 0.000 \). Whereas similar performance was observed with the use MCS, at P-0.012 and \( R^2 \) of 69.8%. It is obvious that at this percentage concentration, better destruction of the bacteria was attained with the Moringa powder solution.

When 20% concentration was used, the regression equation model of the form:

\[
\text{Dosage (mg/l) = 5.37 - 0.0900BOD + 0.00517BOD}
\]

This can further be seen from the ANOVA results where the P – value of 0.001 and \( R^2 \) values of 0.001 and 0.000 is obtained better with the use of MCS is of the form:

\[
\text{Dosage (mg/l) = 3.20 - 0.0208BOD + 0.00056T/Col}
\]

A consistent performance of Moringa in treating the abattoir waste is also demonstrated at 30% concentration. However, it has also been revealing the superiority of the de-oiled Moringa over the ordinary. This can further be seen from the ANOVA results where the P – values of 0.001 and 0.000 is obtained with \( R^2 \) values of 85% and 96% for MPS and MCS respectively. The model equations of:

\[
\text{Dosage (mg/l) = 2.20 - 0.0208BOD + 0.00056T/Col for MPS and Dosage (mg/l) = 6.43 - 0.129BOD+0.00824T/Col for MCS}
\]

3.2 Multiple Linear Models

After obtaining the linear models, which are only applicable to specific parameters, yet it is known that the abattoir waste analysed has variety of composition, the data was also subjected to multiple regressions analysis to re establish the effect of the Natural coagulant in treating the abattoir waste water regardless of the level of pollutants at various concentration.
ability of bacteria removal to 0.00 level of significance. This is the same ability demonstrated by similar model for use with the cake solution which is of the form: Dosage (mg/l) = -4.16 + 0.127BOD – 0.0094T/Col, at 0.00 level of significance. Therefore at this concentration, it does not matter in what form this substance is used as revealed by the predictive values in the ANOVA, where same bacterial removal was achieved.

It is evident that more efficient models are developed with higher Moringa concentrations of 50%, and these models have similar characteristics in either form as the P – values are at significant levels. In this case, 0.000 and 0.007 P-values were obtained in the respective situations. The regression models are of the form: Dosage (mg/l) = 1.45 – 0.00839BOD – 0.000114T/Col for MPS and Dosage (mg/l) = - 246 + 40.4turb – 11.1SS + 0.530Ts – 9.62T/Col for MCS. Both models are applicable for the removal of the bacteria content with R² values of 89.6% and 87.9% respectively. The dosage model using MPS has however, shown to be more preferred with higher level of significance.

IV. SUMMARY OF RESULTS

At the end of the treatment using ordinary and de-oiled Moringa Oleifera at varying concentrations from 10 – 50%, the result showed high initial pollution in all parameters investigated. Dosage applied ranged from 0 – 1.5mg/l. speed of flocculation 0 – 450rpm and settling time of 0 - 210minutes through the treatment process. Minitab statistical software was used in the analysis where linear model equations and multiple regression models were developed. The results of the multiple regression analysis are compared, and the performance of the de-oiled Moringa has demonstrated superiority over ordinary Moringa was used. At 10% concentration, 93.6% reduction in bacteriological parameters was attained with the use of de-oiled Moringa while 69.8% was achieved with ordinary Moringa. At 20% concentration, 87.2% and 83% R² for MPS and MCS were achieved respectively, while at 30% concentration, 85%, 96% R² as 0.001 and 0.000 levels of significance were achieved with MPS and MCS respectively. At this concentration, the best model was developed for effective treatment of the abattoir waste water. When 40% concentration was used, equal levels of significance were achieved whereas at 50% concentration, 89% and 87.9% R² were also attained.

V. CONCLUSION

In conclusion, the models generated were linear and fitting to the regression equation and when multiple regressions were also carried out, it established the linearity of the models and the optimum concentration of the de-oiled Moringa MCS is at 30% concentration. The model developed is of the form: Dosage (mg/l) = 6.43 – 0.129BOD+0.00824T/Col, this can be applicable on any abattoir waste water of different levels of pollution.

REFERENCES