The effect of high concentration of Lonchocarpus Laxiflorus leaf extract on turbidity removal in high turbid water

Abdulaziz Khalil[*], Mustapha Umar Babayo[**], Sulaiman Sulaiman Kabir[***]

[*] Civil Engineering, Bayero University, Kano
[**] Civil Engineering, Nile University of Nigeria, Abuja
[***] Civil Engineering, Bayero University, Kano

DOI: 10.29322/IJSRP.12.09.2022.p12926
http://dx.doi.org/10.29322/IJSRP.12.09.2022.p12926

Paper Received Date: 6th August 2022
Paper Acceptance Date: 7th September 2022
Paper Publication Date: 15th September 2022

Abstract- Natural coagulants can potentially compliment or replace synthetic chemicals used for turbidity removal from raw water. This paper evaluated the turbidity removal efficiency of *Lonchocarpus laxiflorus* leaf extracts on raw water. The turbidity removal efficiency was evaluated at 0.5, 1.0 and 1.5% w/v stock solutions of *Lonchocarpus laxiflorus* leaf extract, using jar test. Results obtained revealed that 1.5% w/v *Lonchocarpus laxiflorus* leaf extract optimally removed turbidity from the synthetic raw water at about 300 mg/L coagulant dose, corresponding to a turbidity removal efficiency of about 98.5% in high turbid synthetic raw waters. This study demonstrated the potentials in using *Lonchocarpus laxiflorus* leaf extract for turbidity removal from raw water.

Index Terms- Turbidity, Wastewater, *Lonchocarpus laxiflorus*, Coagulation, and flocculation.

I. Introduction

Water is one of the most vital natural resources for all life on Earth. The availability and quality of water always have played an important part in determining not only where people can live, but also their quality of life. Industrial water use is valuable resource to the nations industries for such purposes as processing, cleaning, transportation, dilution, and cooling, in manufacturing facilities. Major water-using industries include steel, chemical, paper, and petroleum refining. Industries often reuse the water over and over for more than one purpose. Domestic wastewater is the water that has been used by a community and which contains all the materials added to the water during its use. It is thus composed of human body wastes (faeces and urine) together with the water used for flushing toilets, and sullage, which is the wastewater resulting from personal washing, laundry, food preparation and the cleaning of kitchen utensils [1].

Fresh wastewater is a grey turbid liquid that has an earthy but inoffensive odour. It contains large floating and suspended solids (such as faeces, rags, plastic containers, maize cobs), smaller suspended solids (such as partially disintegrated faeces, paper, vegetable peel) and very small solids in colloidal (i.e non-settleable) suspension, as well as pollutants in true solution. It is objectionable in appearance and hazardous in content, mainly because of the number of disease-causing ('pathogenic') organisms it contains. In warm climates, wastewater can soon lose its content of dissolved oxygen and so become 'stale' or 'septic'. Septic wastewater has an offensive odour, usually of hydrogen sulphide [2].

Turbidity removal is one of the important steps in water treatment process and generally is achieved by coagulation – flocculation – sedimentation process. Common coagulants like alum and iron salts have been widely used in conventional water treatment processes. Recent studies have pointed out many serious drawbacks of using these coagulants. Production of large sludge volume, Alzheimer's disease, reduction in pH and low efficiency of coagulation in low temperature water are some of the problems faced with these coagulants. Also because of high cost and low availability, their use is difficult in many developing countries. Many researchers have worked on natural coagulants produced and extracted from plants, animals and microorganisms [3].

Research work by [4] indicated that *Lonchocarpus laxiflorus* leaves has significant flocculation abilities and have the potential of replacing conventional flocculants for water treatment, due to their efficiency, biodegradability and low sludge production. The cost of this coagulant is less expensive compared to the conventional coagulant (alum) for water purification. It is relatively available in most rural communities where treated water is a scarce resource. In this regard, this research will be conducted to evaluate the effectiveness of *Lonchocarpus laxiflorus* leaves extract on turbidity removal in domestic wastewater.

The history of the use of natural coagulants is long. Natural organic polymers have been used for more than 2000 years in India, Africa, and China as effective coagulants and coagulant aids at high water turbidities. They may be manufactured from plant seeds, leaves, and roots. These natural organic polymers are

This publication is licensed under Creative Commons Attribution CC BY.

interesting because, comparative to the use of synthetic organic polymers containing acrylamide monomers, there is no human health danger and the cost of these natural coagulants would be less expensive than the conventional chemicals alike since it is locally available in most rural communities of Bangladesh. A number of effective coagulants from plant origin have been identified which include; *Nirmali*, *Okra*, red bean, sugar and red maize, *Moringa oleifera*, *Cactus latifera*, *Lonchocarpus laxiflorus* and seed powder of *Prosopis juliflora.* Natural coagulants have bright future and are concerned by many researchers because of their abundant source, low price, environment friendly, multifunction, and biodegradable nature in water purification [5].

II. RESEARCH METHODOLOGY

A. Methods

i. Sample collection

The matured leaves *of Lonchocarpus Laxiflorus* leaves and Kaolin were obtained from Rimi market, Kano municipal, Kano State.

ii. Preparation of the sample

The plant was washed thoroughly under running water to remove dust and any adhering particle and then rinse with distilled water. The sample was air dried for two weeks and dry leaves were grounded using mortar and pestle and were sieved through 150um BS sieve, in order to achieve proper solubility of the active ingredient in the pods. The powdered leaves were stored in a plastic container for use in the experiment.

iii. Preparation of Synthetic Water Sample

To prepare 400NTU synthetic water:
6g of kaolin was dissolved in 500ml of tap water in a beaker, and was mixed for about 10minutes. The sample was allowed to dissolve for 24hours. After 24hours, 2500ml of tap water was diluted in a bucket and was mixed. The initial turbidity was measured as 393NTU.

iv. Preparation of coagulants

Different concentration of *Lonchocarpus laxiflorus* leaf were prepared by dissolving 0.5g, 1.0g and 1.5g of powdered *Lonchocarpus Laxiflorus* leaf weighed on a triple beam balance into 100ml of distilled water, each contained in a conical flask to obtain 0.5%, 1.0% and 1.5% respectively. After that, the solution was shaken properly for about 1 minute to extract and activate the coagulant and antimicrobial proteins in the pod powder.

v. Coagulation Test

Samples of domestic wastewaters were treated by coagulation-flocculation and sedimentation, using *Lonchocarpus laxiflorus* coagulant as a primary coagulant. The quality of the treated wastewater was analyzed and compared to that of the wastewater treated with alum. Experiments were conducted at various dosages of the coagulant, using jar-test equipment. Parameters of quality of the wastewaters were measured before and after the treatment to evaluate the removal efficiency on the major pollutants of concern in wastewater treatment, such as suspended solids.

Conventional jar test [6] was carried out to investigate the treatment performance of the coagulant. The jar test carried out for this research was performed using flocculator (Model: PEF, Serial No. PEF003/11, Spain), which consist of six propellers. Under each propeller, a 500ml capacity beaker was placed containing 250ml of domestic wastewater with same turbidity level. Different dosages of the coagulants were added to five of the beakers with the last beaker kept as reference beaker without adding any dose. The varying dosages are 1ml, 2ml, 3ml, 4ml, and 5ml. The flocculator was then turned ON and left to run for about 30 minutes until the contents in the beakers were completely mixed. After 5 minutes of rapid agitation at 125 rpm, the mixing speed was then lowered to 20 rpm for 25 minutes in order to form flocs. The flocculator was then stopped by turning it off and allowed the sample to stand at near quiescent condition for 1 hour. The sample of the supernatant was collected from each beaker after 1 hour, and its residual turbidity was measured. The optimum dosage of coagulant is the beaker with the lowest turbidity value. In order to obtain a reliable result, the experiments were conducted in duplicate.

Fig. 1. Jar test apparatus

vi. Determination of optimum pH

There are other factors that affect coagulation and flocculation, and also affect the performance of the coagulant; one of these factors is pH. To determine the effect of pH on *Lonchocarpus laxiflorus leaf* performance. The 500ml capacity beakers were filled with synthetic raw water with identical turbidity up to the 250ml mark. Using hydrochloric acid (HCl) or sodium hydroxide (NaOH) solutions, the pH value of the raw water in each of the six beakers were adjusted to the range of drinking water pH specified by WHO which are 6.5, 7.0, 7.5, 8.0, and 8.5. The last beaker served as control beaker. The optimum dose for each coagulant obtained during the determination of the optimum dosage was used. The Jar test similar to that of the determination of optimum dose was performed. The beaker that gave the least

This publication is licensed under Creative Commons Attribution CC BY.

residual turbidity after measuring the turbidity of the supernatant gave the value of the optimum pH for the coagulation process. Similarly for reliable results, all the experiments were performed in duplicate.

B. Determination of Turbidity

i. Calibration of turbidity meter (Portable Turbidity, Model: SGZ-200BS, England):

The standard solution of 100 NTU was used to calibrate the instrument; the detection range selected for the adjustment was 1000 NTU.

Distilled water first added to the sample cell up to the vertical mark and was wiped gently using cotton wool. The sample cell was then inserted in to the turbidity meter and the dial cap placed. Using the set zero knobs, the reading on the turbidity meter was adjusted to zero.

The distilled water was then discarded and a standard solution of 100 NTU was added to the sample cell up to the vertical mark and wiped gently with soft cotton wool. The sample cell was inserted into the turbidity meter and covered with the cap. The stable reading on the turbidity meter was then observed. If the reading was not 100 NTU, using the calibration knob, the reading was adjusted to 100 NTU. The procedure was repeated until the distilled water and the standard solutions gave zero and 100 NTU respectively. The instrument was then ready for used.

ii. Testing of water sample

The water to be measured was added to the sample cell up to the vertical mark, cylindrical glass was wiped gently with cotton wool and it was inserted into the turbidity meter, the turbidity meter cap was placed and reading was observed and recorded as the turbidity of the water sample. The efficiency of turbidity removal of the *Lonchocarpus laxiflorus* leaf extract was calculated in percentage which forms the effectiveness of varying doses of the *Lonchocarpus laxiflorus* leaf extract using the relationship below:

$$\text{Turbidity removal efficiency} = \left(\frac{Ci - Cf}{Ci}\right) \times 100\% \quad \ldots\ldots\ldots\ldots (1)$$

Where C_i and C_f are the initial and final turbidity of the raw water respectively.

C. Determination of pH

i. Testing of water sample

The electrode of the pH meter was first rinsed with distilled water, it was immersed carefully up to the maximum level in the beaker containing the water sample to be tested, and the reading on the pH meter was observed and recorded. The electrode was then removed from the sample and rinsed with distilled water. The electrode was wiped and cleaned to dryness using a soft cotton wool. The procedure was followed for all the remaining samples, and all the pH values were determined.

III. RESULTS AND DISCUSSIONS

The jar test experiment conducted shows the result of coagulation of *Lonchocarpus laxiflorus* leaf using 0.5% w/v, 1% w/v and 1.5% w/v stock solutions. The initial turbidity of the raw water was determined, the turbidity removal efficiencies of the different forms of coagulants were obtained using equation 1.0 from chapter three and the optimum dosage of each coagulant was determined. The dosage corresponding to the highest turbidity removal efficiency or lowest residual turbidity can be said to be optimum.

A. Maximum Dosage of the Coagulant

i. Maximum Dose of Lonchocarpus laxiflorus leaf extract with concentration (0.5% w/v).

Using different doses of 0.5% concentration of the *Lonchocarpus laxiflorus* leaf extract, the turbid water of 393NTU was treated. fig. 2 represents the turbidity removal efficiencies obtained when 20, 40, 60, 80 and 100mg/l doses were added. At maximum dose of 100mg/l, the turbidity removal efficiency was found to be 97.8%. The result is in line with the research findings of [7] who reported 70.21% efficiency with initial turbidity of 47NTU.

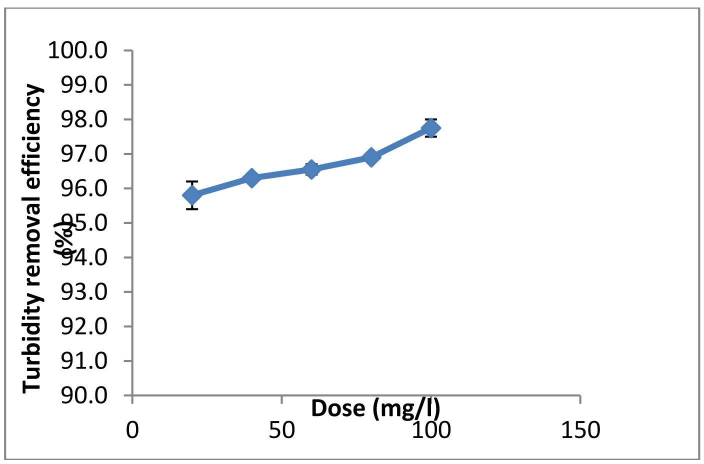

Fig. 2. Turbidity Removal Efficiency versus Dose for 0.5% concentration of *lonchorcarpus laxiflorus* leaf extract.

ii. Maximum Dose of l.laxiflorus leaf extract with concentration (1.0% w/v).

Fig. 3 below explain the results obtained when 393NTU was treated with 0.5% concentration of the *l.laxiflorus* leaf extract. It can be observed that by increasing the concentration of the stock solution to 1.0% w/v the maximum dose was found to be 160mg/l which yields the highest turbidity removal efficiency of 98.4%. This shows that increasing the concentration of the stock solution, increases the turbidity removal efficiency.

This publication is licensed under Creative Commons Attribution CC BY.

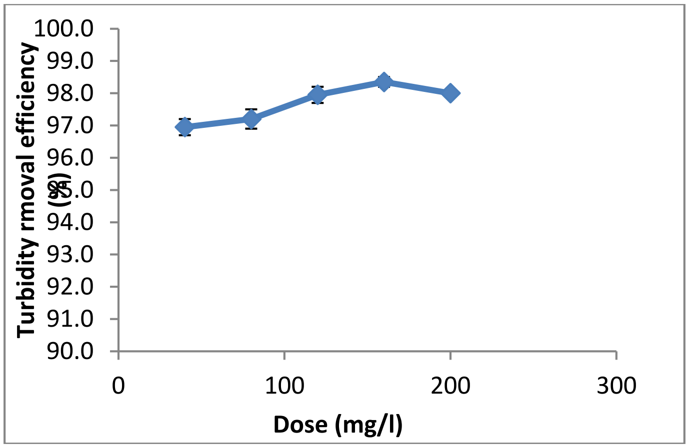

Fig. 3. Turbidity Removal Efficiency versus Dose for 1.0% concentration of *lonchorcarpus laxiflorus* leaf extract.

iii. Maximum Dose of l.laxiflorus leaf extract with concentration (1.5% w/v)

After the jar test experiment was carried out with 1.5% concentration of *l.laxiflorus* leaf extract, the results were presented in the fig. 4 below. The result revealed that, when different range of dosages of *l.laxiflorus* leaf extract were added to the raw water with initial turbidity of 393NTU, the turbidity removal efficiency was found to be 98.5% at an maximum dosage of 300mg/l. This shows that increasing the concentration of the stock solution, increases the turbidity removal efficiency.

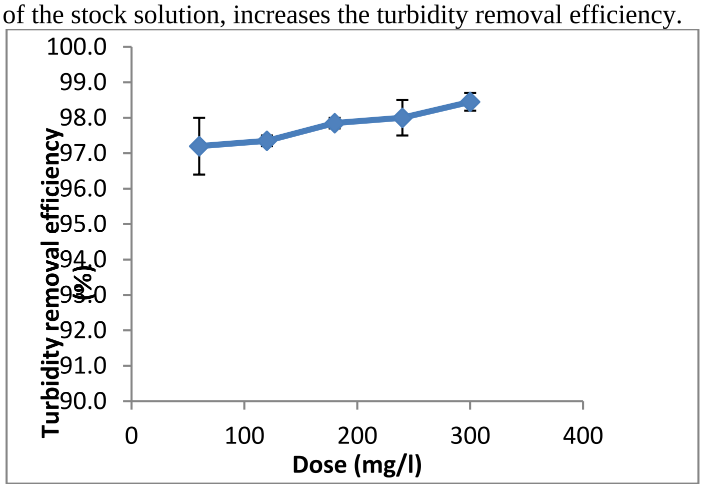

Fig. 4. Turbidity Removal Efficiency versus Dose for 1.5% concentration of *lonchorcarpus laxiflorus* leaf extracts.

B. Maximum pH of Lonchocarpus laxiflorus leaf extract

The optimum doses obtained for 0.5% w/v, 1.0% w/v and 1.5% w/v concentrations were used to treat the high turbid water with various pH values within the limit of WHO drinking water pH range. The turbidity removal efficiency *Lonchocarpus laxiflorus* leaf extract was determined using the optimum dose of various coagulants. The results obtained are presented below:

i. Maximum pH of Lonchocarpus laxiflorus leaf extracts (0.5% w/v)

The fig. 5 below represents the turbidity removal efficiency of 0.5% concentration of *Lonchocarpus laxiflorus* leaf extract when used to treat the raw water with initial turbidity of 393NTU. With different initial pH values, it was observed that, the *Lonchocarpus laxiflorus* leaf extract (0.5% w/v) has higher turbidity removal efficiency of 98.7% at pH value of 6.5. Therefore, the result agreed with the findings of [7], who recorded about 72.3% at pH value of 6.5 by treating 47NTU low turbid water with the same type of coagulant.

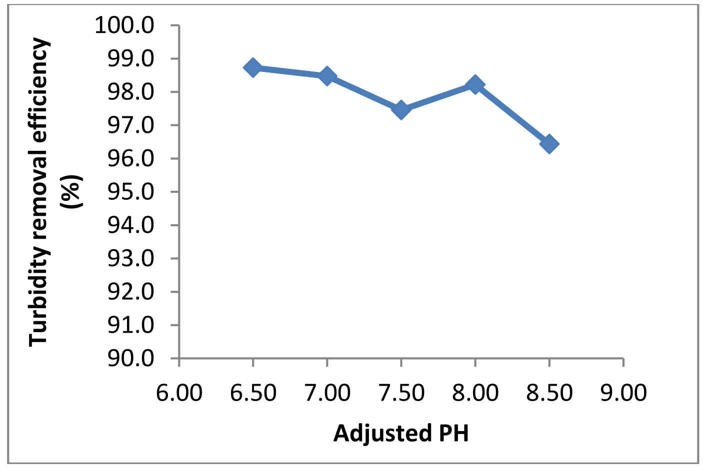

Fig. 5. Turbidity removal efficiency versus adjusted pH with coagulant dose (0.5%)

ii. Maximum pH of Lonchocarpus laxiflorus leaf extracts (1.0% w/v)

The result obtained when the maximum dose of 1.0% concentration were used to treat the raw water with high turbidity of 393NTU with the pH value adjusted within the range of 6.5, 7.0, 7.5, 8.0, 8.5 as specified by the WHO, the highest turbidity removal efficiency of 97.7% was obtained at pH value of 7.5 as illustrated in the fig. 5 below.

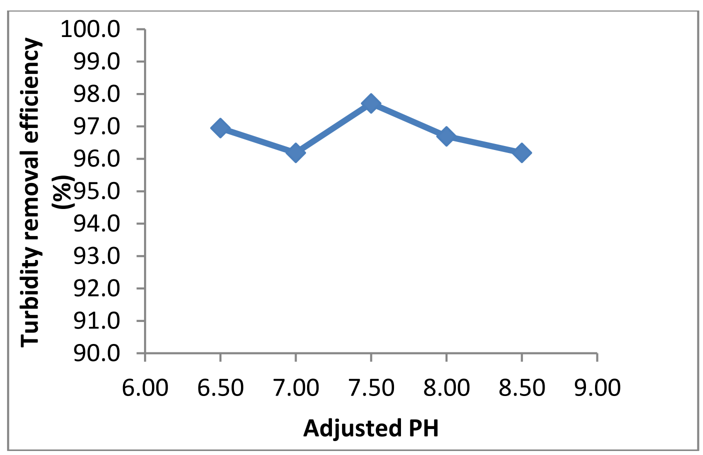

Fig. 6. Turbidity removal efficiency versus adjusted pH with coagulant dose (1.0%)

iii. Maximum pH of Lonchocarpus laxiflorus leaf extracts (1.5% w/v)

The results illustrated in the fig 7 below, represent the optimum pH at which the highest turbidity removal efficiency was obtained when the maximum dose of *Lonchocarpus laxiflorus* leaf extract was used to treat the high turbid water of 393NTU. The highest turbidity removal efficiency of 98.2% was recorded at 6.5 pH value and presented in the fig. 7 below.

This publication is licensed under Creative Commons Attribution CC BY.

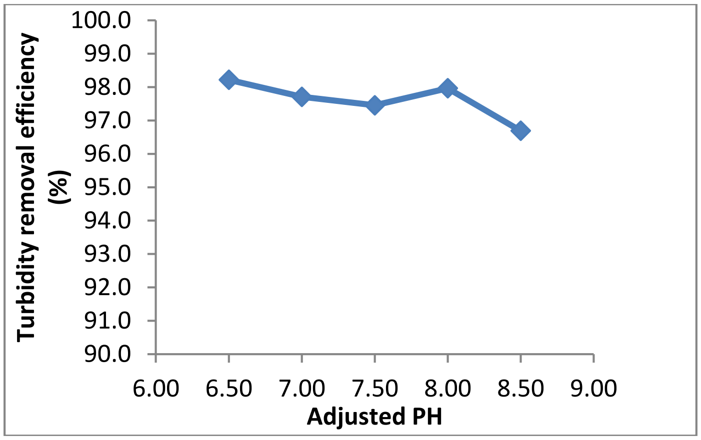

Fig. 7. Turbidity removal efficiency versus adjusted pH with coagulant dose (1.5%)

C. *Comparison on the turbidity removal efficiencies of 0.5%, 1.0% and 1.5% concentrations*

From the result obtained from the jar test experiment, it can be observed that when 0.5% w/v, 1.0% w/v and 1.5% w/v of *Lonchocarpus laxiflorus* leaf extract were coagulated with raw water with high turbidity of 393NTU, the turbidity removal efficiencies of 0.5%, 1.0% and 1.5% concentrations were found to be 97.8% at 100mg/l, 98.4% at 160mg/l and 98.5% at 300mg/l respectively. It can be seen from the results that, the turbidity removal efficiency increases slightly with increase in the *Lonchocarpus laxiflorus* leaf extract. It can also be noted that, for all the three different forms of coagulants, the highest turbidity removal efficiencies were obtained at maximum dose of 100mg/l, 160mg/l and 300mg/l for 0.5% w/v, 1.0% w/v and 1.5% w/v concentration respectively. The turbidity removal efficiencies of all the coagulants at maximum dose were found to be greater than 90%, this shows the effectiveness of using *Lonchocarpus laxiflorus* leaf as primary coagulants for high turbid waters.

The highest turbidity removal efficiencies were obtained between pH values 6.5 to 7.5, within the drinking water pH. The highest turbidity removal efficiency was obtained at pH value of 6.5 using 1.5% w/v concentration. The results for the highest turbidity removal efficiency for the different forms of concentrations are illustrated in the fig. 8 below.

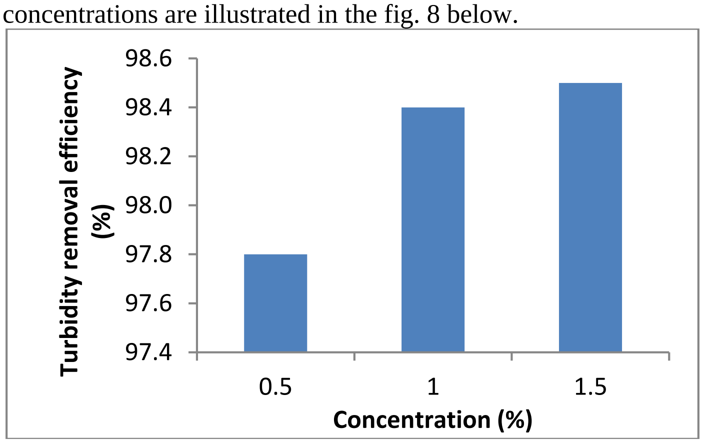

Fig. 8. Turbidity removal efficiency versus concentration for different forms of concentration

.

IV. CONCLUSION

From the results obtained of the analysis using *Lonchocarpus laxiflorus* leaf extract as a coagulant to treat raw water of high turbidity. It has been realized through the findings that *Lonchocarpus laxiflorus* leaf extract has not polluted the raw water but, instead gave it a much better clarity and it is available locally, therefore, the use of this substance should be upheld as a substitute of chemical coagulants. Furthermore, the residual turbidity values of 0.5%, 1.0% and 1.5% concentrations of *Lonchocarpus laxiflorus* leaf extract do not meet the WHO recommended value of drinking water quality. Therefore there is need for further filtration of the water sample.

In rural areas of the developing countries where conventional treatment is economically non-viable, *Lonchocarpus laxiflorus* leaf is recommended for use in treating water. Government should utilize the *Lonchocarpus laxiflorus* leaf extract in treating wastewaters which would drastically reduce the cost of conventional treatment.

ACKNOWLEDGMENT

My deepest gratitude goes to Allah the Sustainer, the Cherisher, the most Beneficent, the most Merciful, Who grant me the will to put all that was needed to complete this project.

My sincere appreciation goes to my supervisor Dr. Kasim Mohammed whose personality I very well admire and whose contribution has pushed me to expand the kind of efforts I have exerted to make this work as original as it can be. Thanks to him I have experienced true research and my knowledge on the subject matter has been broadened, I will never forget you Sir.

I owe a deep sense of gratitude to Dr. James Aduku Department of Civil Engineering Bayero University Kano, for his keen interest, tireless support and encouragement on me at every stage of my research. His prompt inspirations, timely suggestions with kindness and enthusiasm and dynamism have enabled me complete my research.

REFERENCES

[1] Mara, D. D. (2004a). *Domestic wastewater treatment in developing countries*. London ; Sterling, VA: Earthscan Publications.

[2] Mara, D. D. (2004b). *Domestic wastewater treatment in developing countries*. London ; Sterling, VA: Earthscan Publications.

[3] Gidde, M. R., Bhalerao, A. R., & Malusare, C. N. (2012). *Comparative Study of Different Forms of Moringa Oleifera Extracts for Turbidity Removal 16*.

[4] Barminas JT, Santuraki S. (2015). Potential of natural coagulants as a replacement of conventional flocculants for water treatment, unpublished.

[5] Asrafuzzaman, Md., Fakhruddin, A. N. M., & Hossain, Md. A. (2011). Reduction of Turbidity of Water Using Locally Available Natural Coagulants. *ISRN*

[6] Folkard, G. K., Sutherland, J., Shaw, R., (2000) Water clarification using moringa oleifera seed coagulant. unpublished

[7] Habib A. (2011), “ The use of moringa oleifera pod for turbidity removal in low turbid raw water,” unpublished.

This publication is licensed under Creative Commons Attribution CC BY.

AUTHORS

First Author – Abdulaziz Khalil, Bachelor degree, Bayero University, Kano and abdulazizkhalil4118@gmail.com.
Second Author – Mustapha Umar Babayo, Bachelor degree, Nile University of Nigeria, Abuja.

Third Author – Sulaiman Sulaiman Kabir, Bachelor degree, Bayero University, Kano.

Correspondence Author – Author name, email address, alternate email address (if any), contact number.

This publication is licensed under Creative Commons Attribution CC BY.