Comparative Study on the Coagulating Properties of Alum and *Moringa Oleifera*

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Abstract: A comparative analysis was carried out on aluminum sulphate (alum) and Moringa oleifera seeds powder in respect of their coagulating effects in water purification. Various physico-chemical analyses were carried out in water samples treated with both alum and *Moringa oleifera*. These include turbidty, pH, total dissolved solids (TDS), coagulated dirt, calcium ion, total hardness, magnesium ion, dissolved oxygen (DO) and biochemical oxygen demand (BOD). The samples treated with aluminium sulphate gave clearer water (turbidity ranged from 27.60NTU to 10.37NTU) with lower pH values (6.71 to 4.18) compared to samples treated with *Moringa oleifera* seeds powder (with turbidity values of 30.40NTU to 22.97NTU and pH ranged from 6.86 to 6.28). Samples treated with Moringa produced less number of flocs and total dissolved solids (TDS) in the samples than those treated with alum. Alum sample gives 56mg/l, 23.2mg/l, and 32.8mg/l of total hardness, calcium and magnesium respectively, while sample treated with Moringa shows lower values of total hardness, calcium and magnesium as 48mg/l, 18.4mg/l and 29.6mg. l respectively. Higher dissolved oxygen (DO) and biochemical oxygen demand (BOD) were observed in sample of Moringa (16.23mg/l and 10.70mg/l respectively), compared to that of alum with 13.33mg/l and 8.86mg/l of dissolved oxygen (DO) and biochemical oxygen demand (BOD) respectively.

Keyword: Biochemical Oxygen Demand, Coagulating Properties, Moringa Oleifera, Water,

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1.0. Introduction

Water treatment is a process whereby naturally occurring water (raw water) from various sources is put through a series of steps designed to purify it and make it portable for human consumption and industrial purposes, it played a crucial part in the origin of life according to scientist and still has an essential role in maintaining plants and animals life (Bratby, 2006). Several chemical coagulants have been used in conventional water treatment processes for portable water production that include inorganic, synthetic organic polymer and naturally occurring coagulants (Okuda *et al.*, 2001). But the chemicals used for water purification can cause a serious health hazards if an error occurs in their administration during treatment process (Miller et al., 1984). There is therefore the need to investigate the use of non-chemicals which would be available locally in most developing countries; the use of natural materials of plant origin to clarify turbid water is not a new idea (Ndabigengesere *et al.*, 1995). 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 where treated water is a scarce resource. However, the production of water fit for human consumption is not as easy as it sounds. The desired end-product comes into existence because coagulation is a commonly used treatment method apart from flocculation, sedimentation, filtration and disinfection. In fact, in case of rapid-sand filtration plants, it is impossible to achieve crystal-clear water in absence of the coagulation unit in which coagulants are added to incoming water and intense mixing is done for few

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minutes. The purpose of adding coagulants to water is to agglomerate colloidal particles to floc so that they settle readily (Kerri, 2002).

There is evidence that the use of extracts from plant species possessing both coagulating and antimicrobial properties is safe for human health (Muyibi and Okuofu, 1995; Ali et al., 2004). Of the large number of plant materials, it has been shown that Moringa oleifera seed is one of the most effective primary coagulants for water treatment especially in rural communities (Onwuliri and Dawang, 2006). The use of Moringa oleifera has an added advantage over the chemical treatment of water because it is biological and has been reported as edible (Doer, 2005). Among all the materials that had been tested over the years, powder processed from the seeds of *Moringa oleifera* has been shown to be one of the most effective as a primary coagulant for water treatment and can be compared with that of conventional chemical coagulant (alum) (Olsen, 1987)

2.0. EXPERIMENTAL

2.1 Collection and Treatment of Samples

Seeds of Moringa oleifera were purchased from Marina Market in Sokoto, Nigeria. The aluminium sulphate (alum) and raw water were collected from Sokoto water treatment plant. The seeds were peeled to obtain the nuts and dried in an oven for 2 hours. Thereafter, the dried seeds were ground and sieved to a fine powder. The alum was also ground to a fine powder form.

2.1 Methodology

2.1.1 Determination of Turbidity

Turbidity was carried out on supernatants obtained after the treatments have been administered into the beakers containing the raw water using a 2100P turbid meter HACH. The turbidity of the samples was displayed on the LCD panel of the instrument in Nephelometric Turbidity Units (NTU).

2.1.2 Determination of pH

The pH was determined using a 3015 JENWAY pH meter.

2.1.3 Determination of Total Dissolved Solids (TDS)

A 100ml of sample was evaporated to dryness in an oven at 75^{o}C using pre-weighed evaporating dish as described by Ademoroti (1996).

2.1.4 Determination of Coagulated Dirt

The previously weighed pieces of filter paper containing the coagulated dirt from filtration above were dried in an oven at 80OC for 30 minutes, cooled and reweighed.

2.1.5 Determination of Calcium ion

50ml of the sample water was measured into a 250ml flask. 2ml of 2M sodium hydroxide was added and swirled for 2 minutes to precipitate magnesium as Mg (OH) (which may not be visible). Little amount of murexide indicator was added. The colour change is from pink to purple.

2.1.6 Determination of Total Hardness

50ml of water sample was measured and 1ml of ammonium buffer solution to give a pH of 10.0. Few crystals of Eriochrome black T indicator were added. A standard EDTA solution was titrated against the sample until the last reddish tinge disappeared. The colour at the end point of the titration is usually blue.

2.1.7 Determination of Magnesium ion

Magnesium ion was determined by subtracting the amount of calcium ion

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from the amount of total hardness obtained.

2.1.8 Determination of Dissolved Oxygen (DO)

250ml of the sample was transferred into a sample bottle and 2ml each of 0.01M manganese (ll) sulphate (MnSO4), alkaline-iodide-azide reagent and 1ml phosphoric acid (H3PO4) were added with shaking. 200ml of the treated sample from the sample bottle was transferred into a 500ml conical flask and the liberated iodide titrated with standard 0.025M Sodium Thiosulphate ($Na_2S_2O_3$) solution using 2ml of starch as indicator. (Ademoroti, 1996).

2.1.9 Determination of Biochemical Oxygen Demand (BOD)

250ml bottle was carefully filled with the sample to the brim. The stopper was replaced fifteen minutes after. The bottle was enclosed in a black polythene bag (to protect it from light) and incubated for 5 days at a temperature of 20±1oC in the dark. Dissolved oxygen (DO)2 was determined at the end of day five. The difference between (DO) 1 and (DO) 2 gives the BOD5.

RESULTS AND DISCUSSION:

Results: The results are presented in Table 1, 2 and 3 respectably:

Table I: Some parameters determined

Sample	Total hardness (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	DO (mg/l)	BOD (mg/l)
Alum sample	56	23.2	32.8	13.33	8.86
Moringa sample	48	18.4	29.6	16.23	10.70

Table II: Moringa Results

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Concentration	Mean turbidity (NTU)	Mean pH	Mean coagulated dirt (g)	Mean TDS
A (4g/l)	29.98±0.12	6.86±0.12	0.09±0.02	0.02±0.01
B (8g/l)	22.97±0.13	6.64±0.02	0.10±0.01	0.02±0.01
C (12g/l)	28.32±0.38	6.37±0.12	0.23±0.01	0.01±0.00
D (16g/l)	26.80±0.50	6.36±0.08	0.22±0.03	0.01±0.00
E (20g/l)	30.05±0.13	6.28±0.14	0.26±0.01	0.01±0.01
F (24g/l)	30.15±0.35	6.31±0.06	0.25±0.01	0.01±0.01
G (28g/l)	30.40±0.36	6.37±0.05	0.12±0.01	0.01±0.01

Table III: **Aluminium sulphate Results**

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Concentration	Mean turbidity (NTU)	Mean pH	Mean coagulated dirt (g)	Mean TDS (g)
A (4g/l)	27.60±1.13	6.71±0.02	0.09±0.03	0.02±0.01
B (8g/l)	20.87±0.15	6.51±0.02	0.10±0.03	0.02±0.01
C (12g/l)	15.05±1.33	5.83±0.19	0.26±0.01	0.02±0.00
D (16g/l)	10.37±0.75	5.71±0.01	0.26±0.04	0.02±0.01
E (20g/l)	15.60±1.87	5.30±0.13	0.29±0.03	0.02±0.01
F (24g/l)	20.77±1.00	4.18±0.16	0.34±0.05	0.02±0.01
G (28g/l)	18.05±0.54	4.18±0.01	0.18±0.02	0.02±0.01

NOTE: Tables II and III show the mean of triplicate values of turbidity, pH, coagulated dirt and total dissolved solid (TDS) for each sample.

Discussion

From the results obtained above, table I shows that higher concentrations of calcium and magnesium ions in the sample treated with alum which is an indication of its susceptibility to cause hardness of water than sample treated with Moringa with lower values (but all fall within the range of soft water ranging from 0-75mg/l (WHO, 2003)). It also shows that Moringa sample has higher dissolved oxygen and biochemical oxygen demand, which indicates that sample of alum with lower values require less oxygen to degrade the organic matter present in the water sample (because Moringa is organic in nature while alum is inorganic).

In Tables II and III, it could be observed that from sample A (4g/l) - G (28g/l) of both alum and Moringa, the turbidity values are not decreasing uniformly but rather fluctuating, and still comparing samples of alum and Moringa reveals that samples of alum gives lower values, hence, more clear water than that of Moringa. Increase in the concentration of Aluminium sulphate results in increased acidity; this was attributed to the fact that the alum in the treatment produced sulfuric acid which lowered the pH levels. The increase in acidity could be due to the trivalent cationic Aluminium which serves as a Lewis acid, thus, it can accept lone pair of electrons. The reverse was observed with the Moringa treatment, the pH increases with increasing concentrations of the Moringa coagulants. The action of *Moringa oleifera* as coagulant lies in the presence of water soluble cationic proteins in the seeds (Ndabigengesereet al., 1995). This suggests that in water, the basic amino acids present in the protein of Moringa would accept a proton from water resulting in the release of a hydroxyl group making the solution basic. This accounted for the basic pH values

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observed for Moringa treatments compared with alum treatments. From the coagulated dirt values, it can be seen that samples of alum show higher coagulated dirt values compared to that of Moringa, which could be as a result of alum samples exhibits more clear water than that of Moringa. Lower values of total dissolved solids (TDS) are observed in Moringa samples while samples of alum show higher values which is as a result of increase in Aluminium sulphate in samples, thereby remaining in solution by dissolving completely while in Moringa treatments it is partially dissolved, hence un-dissolved substances are filtered out during filtration.

Conclusion

From the above analyses, it could be concluded that both Aluminum sulphates sand *Moringa oleifera* seeds powder served as primary coagulants in water purification. They all gave clear water, but Aluminum sulphate gave clearer water than *Moringa oleifera* seeds powder. So, it could be concluded that Aluminum sulphate remain a better coagulant in water purification than *Moringa oleifera* seeds powder, because it gives more clear water and produced larger, heavier and stronger flocs (coagulated dirt) compared to *Moringa oleifera* seeds powder. But, unlike *Moringa oleifera* samples, Aluminum sulphate produces acidity which requires neutralization.

REFERENCES

Ademoroti, C. (1996). Standard Methods for Water Effluents Analysis. 1st Edition, Fokudex Press Ltd. Ibadan. Pp 111-117.

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Ali, G., El-Taweel, G., and Ali, M. (2004). The Cytotoxicity And Antimicrobial Efficiency of Moringa oleifera Seeds Extracts. International Journal of Environmental Studies61 (6): 699-708.

BratBy, J. (2006). Coagulation And Flocculation In Water And Wastewater Treatment. IWA Publishing Seattle, London. UK. Pp. 3-14.

Doer, B. (2005). Field Guides for Emergency Water Treatment With Moringa oleifera. www.cawst.org/technology/watertreatment/filtrationbiosandanphp. (Retrieved 2012-10-21).

Kerri, K. (2002). Water Treatment Plant Operation.California State University. Sacramento. USA. Pp. 23-28.

Ndabigengesere, A., Narasiah, K., And Talbot, B. (1995). Active Agents And Mechanism Of Coagulation Of Turbid Waters Using Moringa oleifera. Journal of Water Res.29 (2): 703-710.

Okuda, T., Baes, A., And Nishitimas, W. (2001). Isolation And Characterization Of Coagulant Extracted From Moringa oleifera Seed By Salt Solution. Journal of Water Resources.35 (2): 405-410.

Olsen, A. (1987). Low Technology Water Purification ByBentonite Clay And Moringa Oleifera Seeds Flocculation As Performed In Sudanese Village: Effects Of Schist Soma Mansoni Cericariae. Journal of Water Res.21 (4): 81-92.

Miller, R., Kopfer, F., and Ketty, K. (1984). The Occurrence OfAluminium In Drinking Waters. *Journal Of American Water Works Assessment.***76** (1): 84-91.

Muyibi, S., AndOkuofu, C. (1995). Coagulation Of Low Turbid Surface Water With Moringa oleifera Seeds. *International Journal Of Environmental Studies* **46** (8): 263-273.

Onwuliri, F. And Dawang, N. (2006). Antimicrobial Activity Of Aqueous And Ethanolic Leaf Extract Of Drumstick Plant (*Moringa oleifera* Lam) On Some Bacteria Species Associated With Gastro Intestinal Diseases. Nigerian Journal of Botany9 (2): 272-279.

WHO (2003). Guidelines for The Waste Water Quality. General World Health Organization

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