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Effectiveness of *Moringa oleifera* Coagulant Protein as Natural Coagulant aid in Removal of Turbidity and Bacteria from Turbid Waters

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Abstract**—**Coagulation of water involves the use of coagulating agents to bring the suspended matter in the raw water together for settling and the filtration stage. Present study is aimed to examine the effects of aluminum sulfate as coagulant in conjunction with Moringa Oleifera Coagulant Protein as coagulant aid on turbidity, hardness, and bacteria in turbid water. A conventional jar test apparatus was employed for the tests. The best removal was observed at a pH of 7 to 7.5 for all turbidities. Turbidity removal efficiency was resulted between % 80 to % 99 by Moringa Oleifera Coagulant Protein as coagulant aid. Dosage of coagulant and coagulant aid decreased with increasing turbidity. In addition, Moringa Oleifera Coagulant Protein significantly has reduced the required dosage of primary coagulant. Residual Al^{+3} in treated water were less than 0.2 mg/l and meets the environmental protection agency guidelines. The results showed that turbidity reduction of % 85.9- % 98 paralleled by a primary Escherichia coli reduction of 1-3 log units (99.2 – 99.97%) was obtained within the first 1 to 2 h of treatment. In conclusions, Moringa Oleifera Coagulant Protein as coagulant aid can be used for drinking water treatment without the risk of organic or nutrient release. We demonstrated that optimal design method is an efficient approach for optimization of coagulation-flocculation process and appropriate for raw water treatment.

Keywords**—**MOCP, Coagulant aid, turbidity removal, E.coli removal, water, treatment

I. INTRODUCTION

IN recent years, there has been considerable interest in the development of natural coagulants such as *Moringa oleifera* (MO) and chitosan. By using natural coagulants, considerable savings in chemicals and sludge handling cost may be achieved[1].

MO is among the 14 species of trees that belong to the genus Moringaceae [2]. MO seed kernels are biological coagulant consisting of significant quantities of low molecular weight water-soluble proteins, which in solution carry an overall positive charge. MO coagulant is safe and very effective in removing impurities.

The organic and nutrient releases from the seed can be avoided either by purifying the coagulant component of MO[3]. Thus, the MO Coagulant Protein (MOCP) was isolated from the crude extract solution by ion exchange (IEX) chromatography. MOCP was identified as a small molecular mass protein with high surface charge. The active components in MO seeds were found to be soluble cationic proteins and peptides with molecular weight ranging from 6 to 16 kDa and isoelectric pH values around 10[6]. The high positive charge (PI above 10) and small size may suggest that the main destabilization mechanism could be adsorption and charge neutralization [4,5,6]. The protein powder is totally soluble in water and it is stable. The protein powder remained equally active in coagulation even after a storage period of one year in a plastic bottle without any special precaution.

Although, there are many studies on MO coagulant in water treatment, but documents and practical experiences with the effects alum in conjunction with MOCP on turbidity, bacteria have not been reported. The objectives of this research were to determine the optimum dosage of MOCP in conjunction with alum and its effects on turbidity, hardness, and *E.coli* in turbid waters.

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II.MATERIALS AND METHODS

Synthetic turbid water samples were prepared using kaolin clay according to Muyibi, S.A. and Evison, L.M [7]. MOCP was prepared according to Ghebremichael, K.A et al[5,8]. *Escherichia coli* (E.coli) (ATCC1339) was used as the bacteria test in all experiments. Enumeration of E.coli was carried out with most probable number (MPN) technique [9]. A conventional jar test apparatus was employed for the tests [10]. All tests were carried out according to Standard Methods and ASTM [9,10]. Turbidity measurements were conducted using Turbidimeter (HACH, 2100P). pH values of samples were measured using pH meter (EUTECH,1500).

III. RESULTS AND DISCUSSION

Results of optimization of MOCP in conjunction with alum for low, medium and high turbid water are shown in Tables 1, 2and 3. The results showed that the optimum doses of alum and MOCP when used in conjunction, were 15mg/L and 3 mg/L , 15mg/L and 5mg/L, and 17.5mg/L and 1mg/L respectively in low, medium and high turbidity. Residual turbidity reduces to below 5NTU. The overdosing resulted in the saturation of the polymer bridge sites and caused restabilization of the destabilized particles due to insufficient number of particles to form more interparticles bridges. There was an improvement in the floc size when MOCP was used as a coagulant aid and floc settled rapidly as compared to unaided alum. The high positive charge (pI > 10) and small size suggest that the main destabilization mechanism may could be adsorption and charge neutralization.

The total time required for flocculation and settling was obtained less than 40 min. In addition, MOCP significantly was reduced the required dosage of alum between 25 to 62.5%. The results showed that the values of the residual Al^{+3} in low, medium, and high turbidities were between 0.05 to 0.2 mg/L. Our results meet the USEPA standards [11].

The amount of total organic carbon (TOC) released from Moringa Oleifera and MOCP as natural coagulant aid in conjunction with alum have been shown in Fig 1 and Fig 2. To apply of MOCP as coagulant aid in water treatment processes showed that TOC concentrations at all of experiments were between 0.5 to 0.65 mg/L and were less than the background TOC levels. The results showed that MOCP could be used as natural coagulant aid for drinking water treatment with the lowest risks of organic release.

Fig. 3 shows the effect of MOCP on *E.coli* in different turbidities. Rapid reduction of %99.2 – % 99.97 was observed in first 1 hours of process. During the 24h observation period no regrowth was observed. It can be seen that a greater percentage of *E.coli* was eliminated in higher turbidities.

TABLE I DETERMINATION OF OPTIMUM DOSAGES OF ALUM IN COMBINED WITH MOCP IN LOW TURBIDITY (PH=7- 7.5)

Dose of Alum (mg/l)	Dose of MOCP (mg/l)	Initial Turbidity (NTU)	Final Turbidity (NTU)	Removal (%)
0	0	18.6±2	18±1	3.2
15	1.5	16.3±1.5	6.4±1	60.7
15	2	16.9±2	6.7±0.5	60.35
15	2.5	16±3	6.7±0.6	58.12
15	3	21.2±2	4.2±0.3	80.18
15	3.5	20.4±2.5	5±0.7	75.49

TABLE II DETERMINATION OF OPTIMUM DOSAGES OF ALUM IN COMBINED WITH MOCP IN MEDIUM TURBIDITY (PH=7- 7.5)

Dose of alum (mg/)	Dose of MOCP (mg/l)	Initial Turbidity (NTU)	Final Turbidity (NTU)	Removal (%)
0	0	107±2	61±2	43
15	2	100±3	16±1	84
15	3	100±2	10.9±0.9	89
15	4	106±2	6±0.6	94.3
15	5	110±3	4±0.5	96.4
15	6	105±2	11±0.4	89.5

TABLE III DETERMINATION OF OPTIMUM DOSAGES OF ALUM IN COMBINED WITH MOCPIN HIGH TURBIDITY (PH=7- 7.5)

Dose of Alum (mg/l)	Dose of MOCP (mg/l)	Initial Turbidity (NTU)	Final Turbidity (NTU)	Removal (%)
0	0	220±4	181±5	17.7
15	3	204±5	12±3	94
15	4	217±3	14±2	93.5
17.5	1	205±3	2±2	99
17.5	2	217±4	14±3	93.5
17.5	3	204±3	14±3	93.1

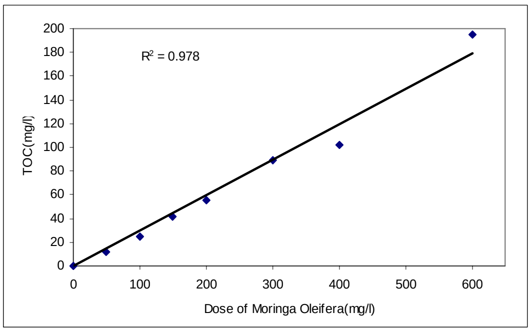

Fig. 1 Plot of TOC(mg/l) verses Moringa oleifera concentration(mg/l)

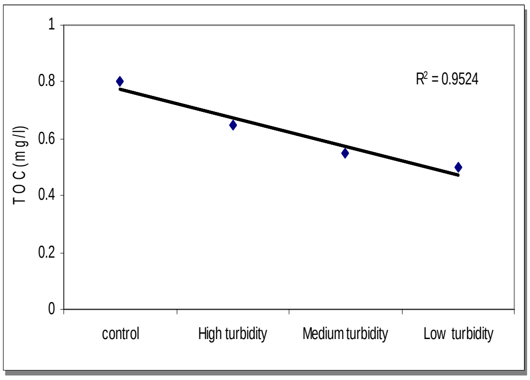

Fig. 2 Plot of TOC(mg/l) verses MOCP concentration(mg/l)

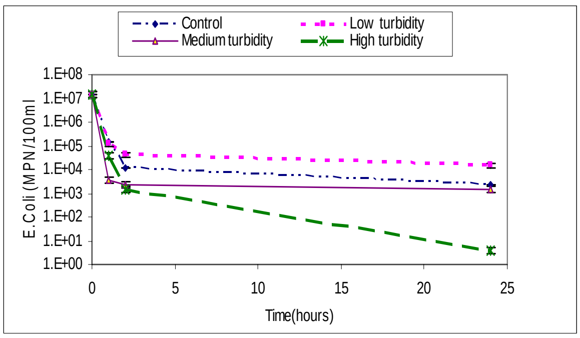

Fig. 3 The effect of Moringa Oleifera Coagulant Protein on E.coli

REFERENCES

[1] A. Diaz, N. Rincon, A. Escorihuela, N. Fernandez, E. Chacin, and C.F. Forster, A preliminary evaluation of turbidity removal by natural coagulants indigenous to Venezuela. Process Biochemistry, 1999. 35: 391-395.

[2] G.K. Folkard, J. Sutherland,.and R. Shaw, Water clarification using Moringa oleifera seed coagulant . *London: Intermediate Technology Publications.* 1999. p.109-112.

[3] K.A. Ghebremichael, Moringa Seed and Pumices as Alternative Natural Materials for Drinking Water Treatment. Sweden : *Royal Institute of Technology (KTH). Stockholm*. *PhD. Thesis* 2004. p.10-11.

[4] H. Agrawal, C. Shee, and A.K. Sharma, Isolation of a 66 kDa Protein with Coagulation Activity from Seeds of Moringa Oleifera. *Research Journal of Agriculture and Biological Sciences.* 2007. 3(5): 418-421.

[5] K.A. Ghebremichael, K.R. Gunaratna, H. Henriksson, H, Brumer, and G. Dalhammer, A simple purification and activity assay of the coagulant protein from Moringa oleifera seed. *Water Research* 2005..39:2338-2344.

[6] H.M. Kwaambwa, and R. Maikoker, A fluorescence spectroscopic study of a coagulating protein extracted from Moringa Oleifera seeds. *Colloids and surfaces B: Biointerfaces.* 2007. p.1-8.

[7] S.A. Muyibi, and L.M. Evison, Coagulation of turbid water and softening of hard water with Moringa oleifera seeds. *Int J Environ Stud.* 1996. .56: 483–495.

[8] M. Suarez, M. Haenni, S. Canarelli, F. Fisch, P. Chodanowski, C. Servis, and O. Michielin, Structure-Function Characterization and Optimization of a Plant- Derived Antibacterial Peptide. *Antimicrobial Agents and Chemotherapy.* 2005.49(9):3847-3857.

[9] APHA, AWWA and WPCF. Standard Methods for the Examination of Water and Wastewater, *21th Edn, Washington DC: American Public Health Association.* 2005.

[10] ASTM. Standard Practice for Coagulation- Flocculation Jar Test of Water E1-1994 R, D 2035-80. *Annual Book of ASTM Standards.* 1995. 11.02.

[11] EPA. National Primary Drinking Water Standards. EPA. 2003. 816-F-03-016.