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EVALUATION OF COAGULATION EFFICIENCY OF NATURAL COAGULANTS (MORINGA OLIEFERA, OKRA) AND ALUM, FOR YAMUNA WATER TREATMENT

LukmanAliyu[1], Mukhtar L.W[2], S.I Abba[3]

[1,3]*Department of Civil Engineering (Environmental), Sharda University, (India)*

[2]*Water Resources and Engineering Construction Agency, (Kano)*

ABSTRACT

The chemical coagulants are widely used for turbidity removal in water but they have health's problems associated with them and are additionally uneconomical for use in developing countries. The present work aimed to the assessment to the coagulation efficiency of natural coagulants in water. Primarily the basic operational parameters are physical and chemical parameters, pH and coagulants dosages will be optimized. Coagulation ability of both seeds extracts will be assess with different natural coagulants by the use of standard jar test experiment in river water (Yamuna) with various coagulant doses of 100, 150 and 200mg/l using Moringa oliefera and 150, 200, and 250mg/l using okra. Its positive coagulation activity was measured on the basis of removal of Turbidity, Total dissolved solid, Suspended solids, pH, Hardness, Chloride and Alkalinity. The efficiency of the results will be compared to that of Alum at doses 10, 20, 30 and 40mg/l and national drinking water quality (India).

I INTRODUCTION

1.3 billion People in developing world lack safe drinking water (IRC, 1994), and 80% of diseases in developing countries is as a result of an inadequate water supply and sanitation (Schertenlieb, 1992).

These are facts that cannot be ignored, considering a global population is currently growing at the rate of around 1.13% per year. The average population change is currently around 8million per year (IRC 2015)

Many plants have been used to clarify water. Naturally occurring coagulants are usually presumed safe for human health. These include Moringa oleifera, Moringa stenopetala, Viciafaba (Jahnn S.S.A 1988), Canavaliaensiformis, Bombaxconstatum (Faby J.A 1993) and okra (Nacoulima G. Piro2000). Sutherland et. al 1994) have reported Crushed Moringa oleifera, seed have been found to be viable replacement coagulant for chemicals such as aluminum sulphate (alum). (Yao et al 2005) studied the flocculating activities of the fresh

stems of mucilage of Gumbo (Hibiscus esculents) and achieved the lowering of turbidity. Natural coagulants are often extracts of indigenous materials which are potentially more readily available in some parts of the world than proprietary chemical coagulants. This is of major importance of many developing countries, where important chemical coagulants are not easily available and can be expensive, involving the use of valuable foreign exchange. The cost of Alum the most, the most commonly used coagulant, is estimated to be as much as seven times more expensive in many African countries than in the U.S.A which need to import it from Europe (Schulz and Okun, 1992). Okra is cultivated in tropical, subtropical and warm temperate regions around the world (National Research Council, 2006). According to the information available in the literature, okra has been found not only to be edible but also used as a coagulant in wastewater treatment. In fact, some researchers have used this same plant, and some other natural coagulants, for wastewater treatment in the past. For instance, Ghebremichael (2005) used okra seed for treatment of tannery effluent and they found that okra seed was able to act as a very effective flocculent, capable of removing more than 95 percent suspended solid and 69 percent dissolved solid from the effluent. His results showed that polysaccharides (mucilage) obtained from okra and fenugreek was capable of removing 90-94% of suspended solids and 30-44% of total dissolved solids. Anto (2009) also worked on the use of natural coagulants for water treatment and discovered that the sludge produced from the use of Moringa oliefera was able to give water the turbidity of which was 20-30% better than that obtained from the use of alum. The rapid increase in the population of the world has led to higher demand of water supply. The cost of treating water with chemicals and environmental pollution caused by sludge disposal have necessitated the idea of investigating ways to supplements or replace the use of chemical coagulants with locally indigenous plant materials. As such, this research is contributing to this good development by using a local material (okra) for wastewater treatment through investigating the use of okra in the treatment of surface water of River Rima and Goronyo Dam.

II MATERIALS AND METHODS

2.1 Materials

All the materials were purchased from nearby market. In this study seeds of M. Oliefera, and Okra seeds were used for preparation of coagulant extract. Hydrochloric acid and sodium hydroxide were used to adjust pH of stock solution. Detailed description of coagulant extract and water sample collection were described.

2.2 Moringa Oliefera (Drum stick)

Moringa oliefera is the most widely cultivated species of Monogenetic family, the moringaceae, that is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan, it is already an important crop in India, Ethiopia, the Philippines and the Sudan and it is being grown in west, east and south of Africa, Tropical Asia, Latin America, the Caribbean, Florida and Pacific Islands(Jedd 2005).

2.3 Okra (Lady Finger or Gumbo)

Okra AbelmoschusesculentusL.Moench, is an economically important vegetable crop grown in tropical and subtropical parts of the world. In the range of studied, it is observed that whatever the volume of gumbo mucilage, the turbidity decreases when the pH increases. The mucilage, from its sticky nature, contains polymer molecules (Nacoulima et al, 2000).The flocculating activity can be either due to a chemical reaction, or a complex formation.

2.4 Water Sample collection

The water sample of the research was collected from Delhi canal. All sample of water collected was used within the period range of 2-3 weeks and stored at temperature of about 2^0c using a refrigerator. Two different samples and volume of 30litres each were collected, and the raw characteristics were recorded.

2.5 Preparation of coagulants seeds powder

The extractwas prepared from the seeds:

❖ Moringa Oliefera and okra plants origin materials were obtained from the market. M. oliefera seeds and okra seeds were removed from the pod and sun dried for 24hours at an ambient temperature of about (23^0C-25^0C). The dried seeds were grinded using a Pestle and mortar to obtain in powdered form. The powder was sieved and stored in a sterile bottle in a refrigerator for about 3^0C temp.(Muyibi et al 1995)

2.6 Preparation of coagulants stock solution

1 g of powder was weighed in a beam balance and mixed with 100 ml distilled or demonized water to form 100 ml of suspension, resulting in 10,000mg/l

Concentration(1%). The suspension was then thoroughly mixed using a clean magnetic stirrer for 5 min to extract the active component, followed by filtration of the solution through a piece of clean white muslin cloth so as to remove the residue. The obtained stock solutions from each of these methods were preserved at -4°C until analyzed(Schwarz 2000).

Fig 1: Moringa Oliefera pod

Fig 2: Moringa Oliefera seeds

Figure 3: Okra

Figure 4: Okra seeds

III RESULTS AND DISCUSSIONS

3.1 Results

Table 1: Results of Raw water sample

S/N	Parameters	Raw water characteristics	Indian standard of drinking water quality limits Desirable/permissible
1	Turbidity(NTU)	18.15	1.00/5.00
2	Total dissolves solids(mg/l)	380	500/200
3	Total suspended solids (mg/l)	343	<30
4	Total solids (mg/l)	781	-
5	pH	8.51	6.5-8.5
6	Hardness (mg/l) of $caco_3$	228	200/600
7	Chloride (mg/l)	30.14	250/1000
8	Alkalinity (mg/l)	104.18	200/600

Table 2: Results of Moringa Oliefera

S/N	Parameters	100mg/l dosage	150mg/l dosage	200mg/l dosage	% of highest removal
1	Turbidity(NTU)	4.95±0.02	4.23±0.01	4.37±0.03	77%
2	Total dissolve solids(mg/l)	269±1	230±1.5	240±2.0	46%
3	Suspended solids (mg/l)	235±1.44	219±0.57	227±3.39	38%
4	Total Solids (mg/l)	504±2.38	449±1.47	460±2.64	43%
5	pH	7.63±0.04	7.53±0.01	7.58±0.04	11%

Table 3: Results of Okra seeds

S/N	Parameters	150mg/l dosage	200mg/l dosage	250mg/l dosage	% of highest removal
1	Turbidity (NTU)	5.14±0.03	4.40±0.04	4.58±0.03	75%
2	Total dissolve solids (mg/l)	279±3.74	235±1.47	242±0.91	44%
3	Suspended solids (mg/l)	245±6.02	229±1.0	235±1.22	36%
4	Total Solids (mg/l)	524±2.19	462±1.29	476±1.30	41%
5	pH	7.71±0.04	7.58±0.03	7.61±0.03	10%

Table 4: Results of Alum treatment

S/N	Parameters	10mg/l dosage	20mg/l dosage	30mg/l dosage	40mg/l dosage	% of Highest removal
1	Turbidity (NTU)	4.28	4.04	3.61	3.72	80%
2	Total dissolve solids (mg/l)	235	221	211	215	45%
3	Suspended solids (mg/l)	200	207	190	197	44%
4	Total solids (mg/l)	435	428	401	412	40%
5	pH	7.54	7.52	7.50	7.50	11%

Table 5: Results of Sludge Analysis

S/N	Parameters	10mg/l	20mg/l	30mg/l	40mg/l	100mg/l	150mg/l	200mg/l	250mg/l
1	M. oliefera seeds (g)	-	-	-	-	4.01	4.23	4.13	-
2	Okra seeds(mg/l)	-	-	-	-	3.90	4.10	4.05	
3	Alum	5.52	5.63	5.75	5.71				

3.2 Discussions

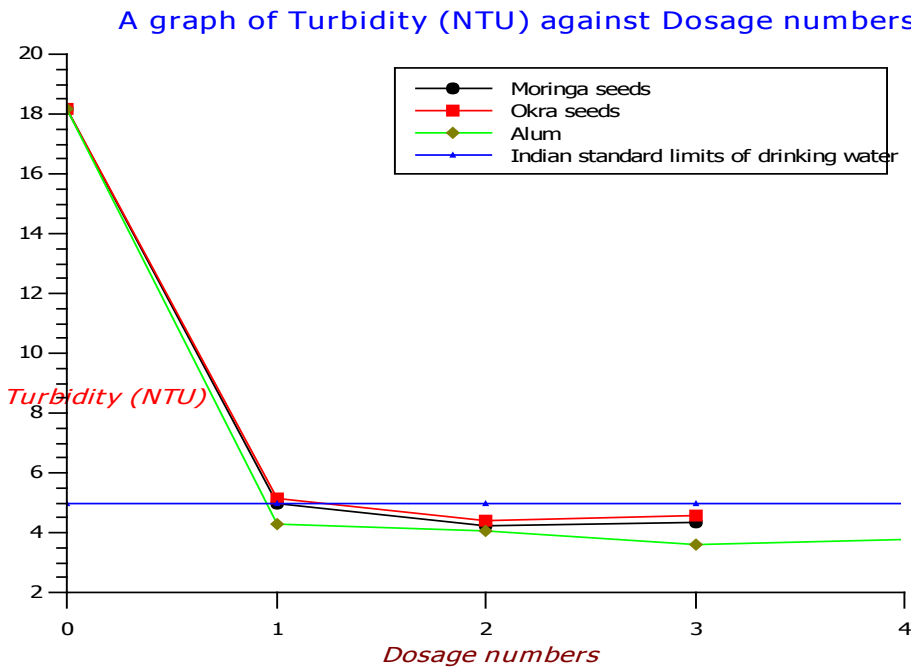

Figure 5: A graph that shows relationship between the coagulants seeds Turbidity (NTU) and Dosages (mg/l)

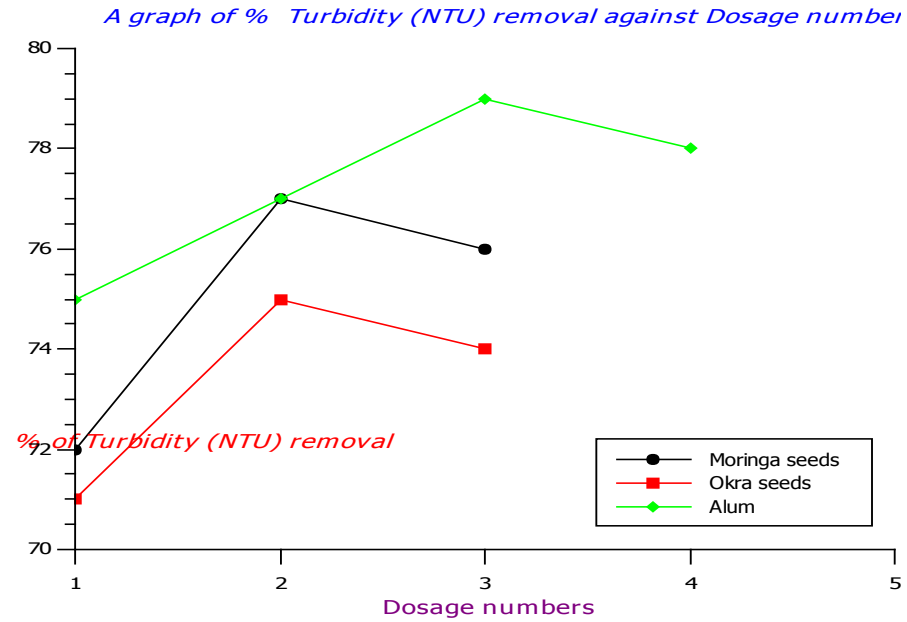

Figure 6: Percentage of Turbidity (NTU) removal using different coagulants

Table 6: shows different coagulants Dosages in Turbidity graph

Dosages (mg/l)	0	1	2	3	4
Moringa seeds	**18.15**	100	150	200	-
Okra seeds	**18.15**	150	200	250	-
Alum	**18.15**	10	20	30	40

The turbidity value was observed to be 18.15(NTU) in the raw water sample, which is above both national and international standards of drinking water quality. After the treatment with various coagulants, the turbidity decrease to 4.23 (NTU) using Moringa oliefera seeds and 4.40(NTU) on Okra seeds with optimum dosages of 150 and 200mg/l respectively, while Alum is 3.61 with coagulant dosage of 30mg/l. The highest removal efficiency of M. Oliefera is 77% while that of okra is 75%.

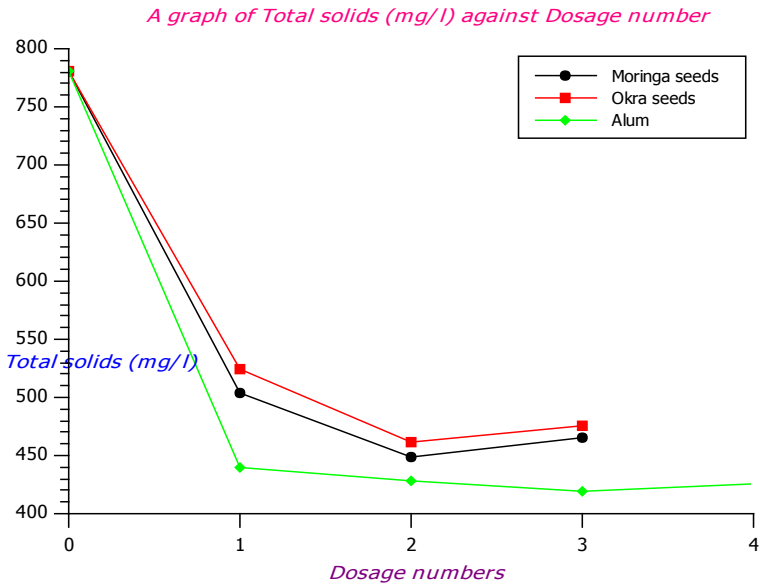

Figure 7: The effects of coagulants on Total solids in water

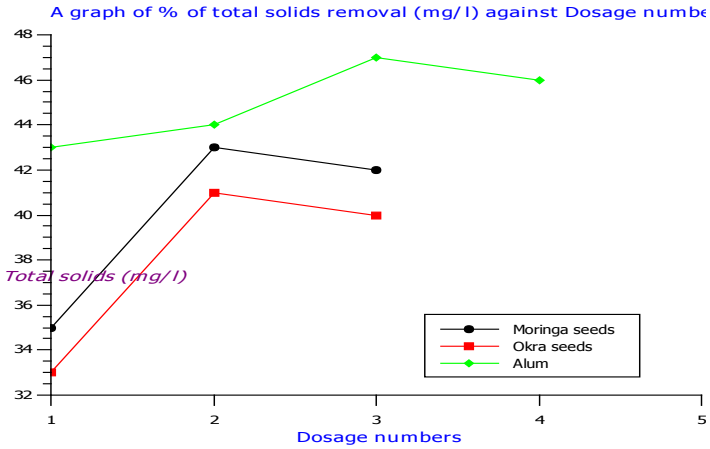

Figure 8: The percentage of Total solids (mg/l) removal using different coagulants

Table 7: Shows different coagulants dosages on suspended solids graph

Dosages (mg/l)	0	1	2	3	4
Moringa seeds	**781**	100	150	200	-
Okra seeds	**781**	150	200	250	-
Alum	**781**	10	20	30	40

Total solids include all the mobile charged ions present including (fats, salts and the suspended solids). The Total solids was initially found to be 781mg/l in the river water sample, and when treated with the natural seeds coagulants of Moringa Oliefera and Okra, it reduces to 449 and 462mg/l, with an optimum coagulant of 150mg/l and 200mg/l respectively and removal of efficiency of 43% on M. oliefera and 41% of Okra. Upon Alum treatment the Total solids was found to be 421mg/l with optimum coagulant of 30mg/l and removal efficiency of 47%.

IV SUMMARY AND CONCLUSION

Moringa Oliefera seedsand Okra seedsact as a natural coagulant, flocculent for water treatment based on the research. Both reduces the level of all tested parameters present in the water sample, although Moringa seed is more effective than okra seed with the highest purity in turbidity at 77% efficiency and 75% that of okra seeds, and optimum coagulant dosage of 150mg/l and 200mg/l respectively. While Alum has 80% efficiency at 30mg/l but produces more sludge than the natural coagulants.

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