WATER TREATMENT USING MORINGA OLEIFERA SEEDS AND KERNALS IN STREAM WATER

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Abstract

Need of good drinking water increases in all countries, particularly in developing countries like India. In such countries people drinks untreated water due to high cost of water treatment methods. So it is necessary to discover some sustainable and cost effective methods to replace the current methods. The main purpose of this study is to replace the chemical coagulant Alum by natural coagulant Moringa oleifera, commonly known as Drumstick. The seeds of Moringa have the capacity of coagulation as well as antibacterial activities. This substitution is necessary because of high cost of Alum and its potential to produce Alzemer's disease. From previous works it is found that Moringa can replace Alum as a coagulant. But when compared to Alum, the anti-microbial activity of Moringa is relatively less. So we can combine alum and Moringa powder for coagulation. It may give good results in both coagulation and bacterial reduction.

Keywords: *Moringa oleifera, Water treatment, Bacterial reduction*

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1. INTRODUCTION

Water is an essential component of life and search for hygienic and esthetically acceptable water was already a subject of priority concern. The world Health Organization (WHO) defines potable water as it is clear, transparent, odourless, no objectionable taste and free from microorganisms or chemicals in concentration lead to a risk to human health. A large number of people are exposed to the hazards from pollutants in potable water. To remove those pollutants and to obtain palatable drinking water, water treatment usually comprises water clarification and disinfection in conventional water treatment. Many chemical coagulants are widely used in conventional water treatment processes for tap water production. However, studies have reported that all these chemicals lead to many health problems. Naturally occurring coagulants are biodegradable and presumed safe for human health. The use of natural material of plant origin to clarify turbid raw water is not a new idea.

1.1 Physical Properties of Pods and Seeds of Moringa:

- Average weight of pod (g) 7.60 - 7.95
- Average weight of seeds (g) / pod 3.59 5.03 4.83
- Average number of seeds / pod 12 17 16
- Average weight (g) / 100 seeds 29.9 29.6 30.2
- Average weight of kernels (g)/100 seeds 21.2 - 22.5
- Percent weight of kernel in relation to entire seed 72.5 - 74.5
- Percent weight of hull in relation to entire seed 27.5 - 25.5
- Moisture in kernel (%) 4.5 - 6.5
- Moisture in hull (%) 9.2 - 12.9
- Moisture in whole seed (%) 5.8 - 7.5

1.2 Water Purification:

When crushed into a powder, the seeds from Moringa trees act as a natural flocculent which can be used to purify dirty water, eliminating between 90-99% of bacteria. The powder joins to the solids in the water and sinks to the bottom. The residue (seed cake) left over from making Ben Oil from the seeds. The sludge left over from the water after treatment can also be used as a bio-fertilizer/bio-compost which has been shown to increase yields of other staple food crops. This therefore presents an excellent cycle for the seeds which can be used by rural communities: firstly using the seeds to make Ben Oil then using the seed cake from the oil extraction process to purify water and then finally using the sludge left over from the water purification process as a bio-fertilizer for other crops.

1.3 Coagulant Dose Requirement:

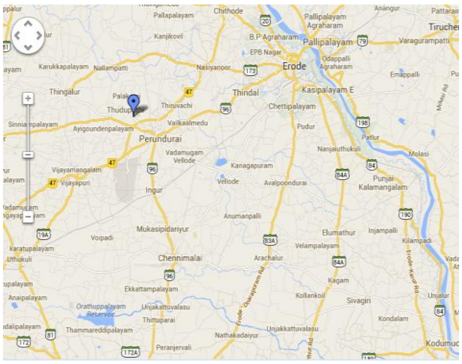
As for all coagulants, the amount of seed required will vary depending on the raw water source and on the raw water quality. One advantage of seed use is that, in general, there is a wide dose range over which effective treatment may be achieved and maintained. jar testing should be carried out to determine more specific dose requirements for the raw water. Dosages are given as equivalent weight of seed powder or press cake material required to make up the dosing solution.

1.4 Economic Analysis:

Moringa seed contains 40% by weight of oil and laboratory work at Leicester confirmed that the press cake remaining after oil extraction still contains the active coagulant. The high quality and hence high market value of this vegetable oil was confirmed during the recent visit to Malawi. The oil is of equal value as a cooking oil and as the principal ingredient for soap manufacture. The demand for oil in Malawi far outstrips the available raw materials required for extraction. An economic analysis in the Malawi context reveals that the press cake may be obtained at zero net cost as a by-product of oil extraction.

2. MATERIALS AND METHODS

Palakkarai is located within Perundurai. Due to unregulated population growth and industrial development, Perundurai experiences an exponential growth in the vehicular usage and fuel consumption, which results in an increased concentration of particulate matter present in the river water."collect the palakarai river water to treated.



2.1 Turbidity:

The term turbid is applied to waters containing fine suspended impurities (clay, sand, decomposed vegetable and animal matters) that interface with the passage of light through water. Turbidity in water may be measured on standard silica scale. Turbidity meter and Nephelometer are the instruments used for the determination of turbidity in water. The recommended concentration of turbidity in drinking water should be less than 5 units,

2.2 Totalcoliform Using Most Probable Number (MPN) Procedure:

In determining the most probable number of coli forms that were Present in each of the treated water samples. Lactose broth was used as the medium for the bacteria growth. Two types of the lactose broth were prepared. These were the single strength lactose broth (SSLB) and the double strength lactose broth (DSLB).In the single strength, 13.0 g of the lactose powder was weighed and dissolved in 1000 ml of distilled water. An amount of 0.08 g Alazin Red was measured and added to the solution. The solution was then stirred gently for 10 min on a magnetic stirrer to dissolve and mix well. The double strength was prepared using exactly a double of each of the weights of the reagents used. This solution was put on a magnetic stirrer and stirred gently for 10 min. A volume of 1.0 ml of the control, 10.0 and 12.0 g of both *Moringa* and alum treatments supernatants were measured and introduced into test tubes containing 10 ml of the double strength lactose broth and 10 ml of the single strength lactose broth. Another volume of 0.1 ml of the same supernatants above was measured and introduced into another set of test tubes containing 10 ml of the single strength lactose broth. The test tubes were then incubated for 24 h at 37°C after which they were analyzed.

2.3 Coagulants Used:

The seeds were harvested when they were fully matured. This is determined by observing if there are any cracked pods on the plants. The pods that were plucked were cracked to obtain the seeds which were air-dried at 40°C for two days. The shells surrounding the seed kernels were removed using knife and the kernels were pounded using laboratory mortar and pestle into powder and sieved using a strainer with a pore size of 2.5 mm2 to obtain a fine powder. This was the coagulant prepared from *Moringa.*

2.4 Preparation of Seeds Extract:

Dry Moringa oleifera seeds were obtained from the Botanical Garden. The seeds were air dried and after being ground up the ground material were sieve No. 26 and kept in a dark well closed container.

3. RESULTS AND DISCUSSION

3.1 Turbidity Removal

The initial turbidity of the source water ranged from 58 NTU. Efficiency of turbidity removal for *M.* oleifera expressed as a percentage and normalized to the untreated control is given in Figures. The 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 200 mg/L of powdered coagulant, respectively. Above a coagulant dose of 6g per 600 ml sample volume, efficiency was high at 94% or greater removal. Also, Figures shows the comparative results obtained for alum.

3.2 Total Coliform Reduction

Total Coliform for the source water ranged from 62 CFU. Total Coli form reduction for *M.* oleifera expressed as a percentage and normalized to the untreated control is given in Figures. Removal of turbidity by some benefit of Total Coliform reduction resulting from the attachment of bacteria to the colloidal sol. A reduction of approximately 87% is realized with dosages of 6g per 600 ml sample volume; however, the higher dose as efficient. Total Coliform reduction was similar to the control at the low dosages examined; however, at the 6g at 600 ml dose. Total Coliform counts were essentially zero, reflecting the high turbidity removal achieved concurrent with the possibility of some disinfection at the higher dose.

Table: 1 Mixture of 200 ml Stream water + 2g M.O Powder

Mixture	Turbidity	Bacterial count
10ml	58	62
20 ml	57.3	61
30 ml	55.8	60
40 ml	54.2	58
50ml	51.7	56

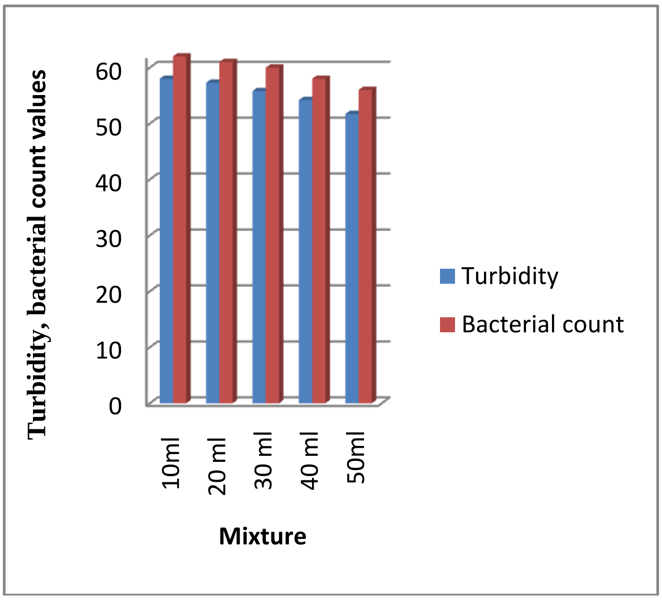


Fig: 1 Mixture of 200 ml Stream water + 2g M.O Powder

Efficiency of turbidity removal for *M.* oleifera in 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 200 mg/L of 2g powdered coagulant . Above a coagulant dose of 50 ml per 200 ml sample volume, efficiency was high removal in 51.7at turbidity and 56at bacterial count.

Table: 2 Mixture of 200 ml Stream water + 4g M.O Powder:

Mixture	Turbidity	Bacterial count
10ml	50	56
20 ml	48.23	53
30 ml	48	52
40 ml	47.32	50
50ml	46	48

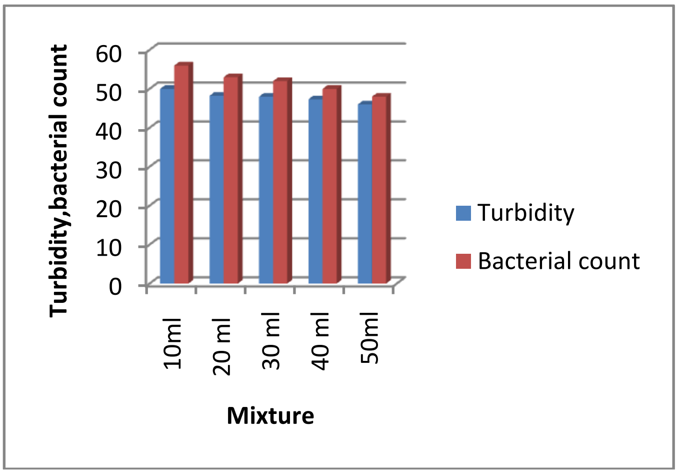


Fig: 2 Mixture of 200 ml Stream water + 4g M.O Powder

Efficiency of turbidity removal for *M.* oleifera in 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 200 mg/L of 4g powdered coagulant . Above a coagulant dose of 50 ml per 200 ml sample volume, efficiency was high removal in 46at turbidity and 48 at bacterial count.

Table: 3 Mixture of 200 ml Stream water + 6g M.O Powder:

Mixture	Turbidity	Bacterial count
10 ml	46	47
20 ml	45.34	46
30ml	43.5	46
40 ml	43	45
50ml	42.8	44

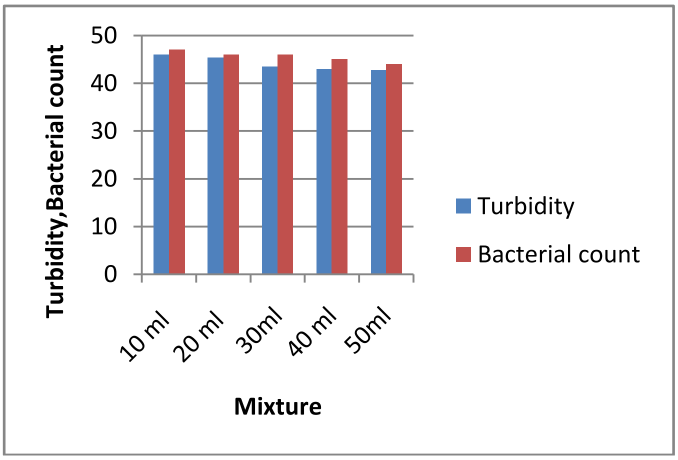


Fig: 3 Mixture of 200 ml Stream water + 6g M.O Powder

Efficiency of turbidity removal for *M.* oleifera in 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 200 mg/L of 6g powdered coagulant . Above a coagulant dose of 50 ml per 200 ml sample volume, efficiency was high removal in 42.8at turbidity and 44 at bacterial count.

Table: 4 Mixture of 400 ml Stream water + 2g M.O Powder:

Mixture	Turbidity	Bacterial count
10 ml	42	43
20ml	40.53	41
30 ml	39.8	40
40 ml	38	38
50ml	37.73	37

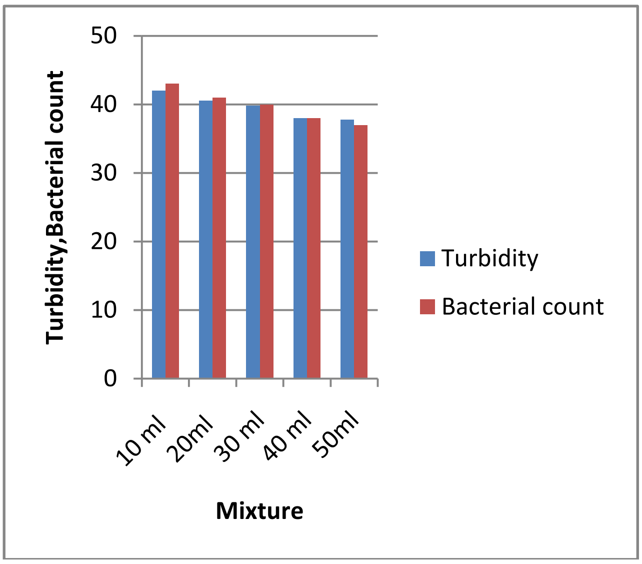


Fig: 4 Mixture of 400 ml Stream water + 2g M.O Powder

Efficiency of turbidity removal for *M.* oleifera in 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 400 mg/L of 2g powdered coagulant . Above a coagulant dose of 50 ml per 400 ml sample volume, efficiency was high removal in 37.73at turbidity and 37 at bacterial count.

Table: 5 Mixture of 400 ml Stream water + 4g M.O Powder:

Mixture	Turbidity	Bacterial count
10 ml	31	32
20 ml	30.4	30
30 ml	29.53	28
40 ml	28.44	26
50ml	28.27	25

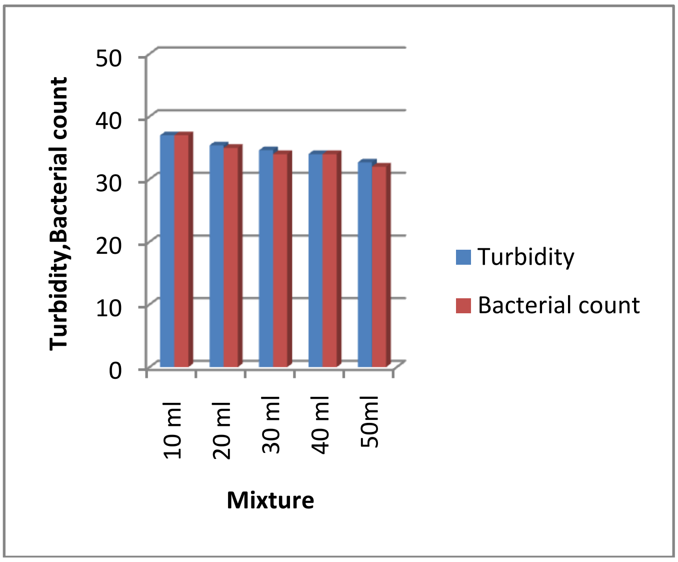


Fig: 5 Mixture of 400 ml stream water + 4 gm M.O Powder

Efficiency of turbidity removal for *M.* oleifera in 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 400 mg/L of 4g powdered coagulant . Above a coagulant dose of 50 ml per 400 ml sample volume, efficiency was high removal in 32.69at turbidity and 32 at bacterial count.

Table: 6 Mixture of 400 ml Stream water + 6g M.O Powder:

Mixture	Turbidity	Bacterial count
10 ml	37	37
20 ml	35.4	35
30 ml	34.62	34
40 ml	34	34
50ml	32.69	32

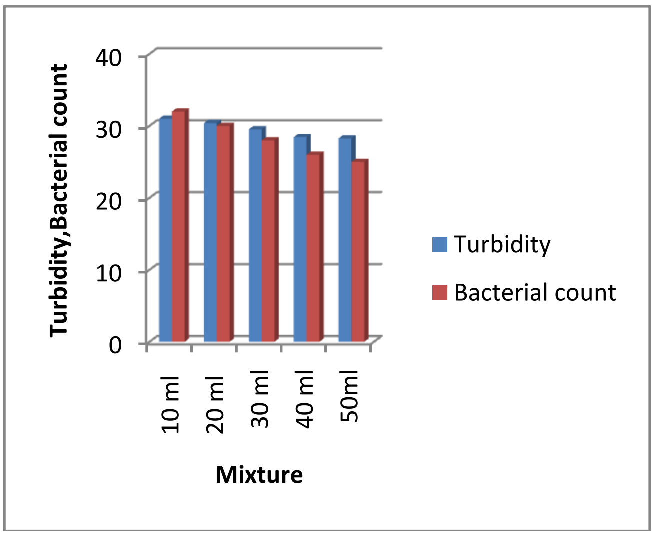


Fig: 6 Mixture of 400 gm stream water + 6 gm M.O Powder

Efficiency of turbidity removal for *M.* oleifera in 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 400 mg/L of 4g powdered coagulant . Above a coagulant dose of 50 ml per 400 ml sample volume, efficiency was high removal in 28.25 at turbidity and 25 at bacterial count.

Table: 7 Mixture of 600 ml Stream water + 2g M.O Powder:

Mixture	Turbidity	Bacterial count
10ml	27	24
20 ml	26.8	22
30 ml	25	22
40 ml	24.32	20
50ml	23.69	18

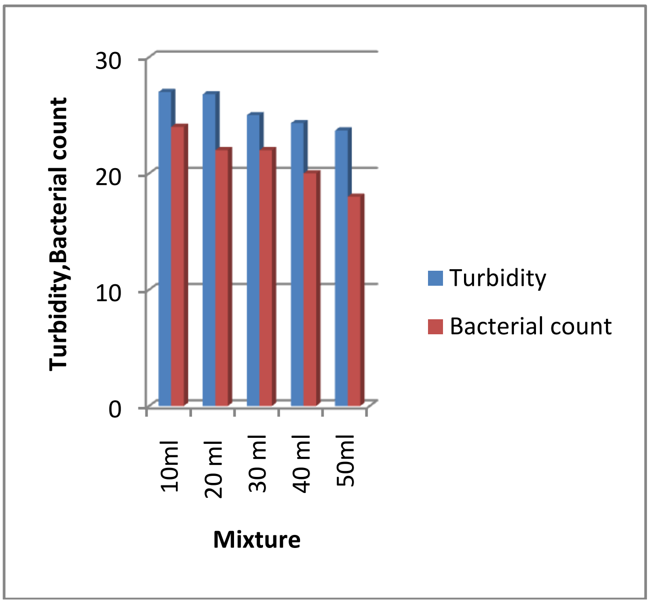


Fig: 7 Mixture of 600 gm stream water + 2 gm M.O Powder

Efficiency of turbidity removal for *M.* oleifera in 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 600 mg/L of 2g powdered coagulant . Above a coagulant dose of 50 ml per 200 ml sample volume, efficiency was high removal in 23.69at turbidity and 18 at bacterial count.

Table: 8 Mixture of 600 ml Stream water + 4g M.O Powder

Mixture	Turbidity	Bacterial count
10ml	23	18
20 ml	22.9	17
30 ml	22	15
40 ml	21.64	13
50ml	21	12

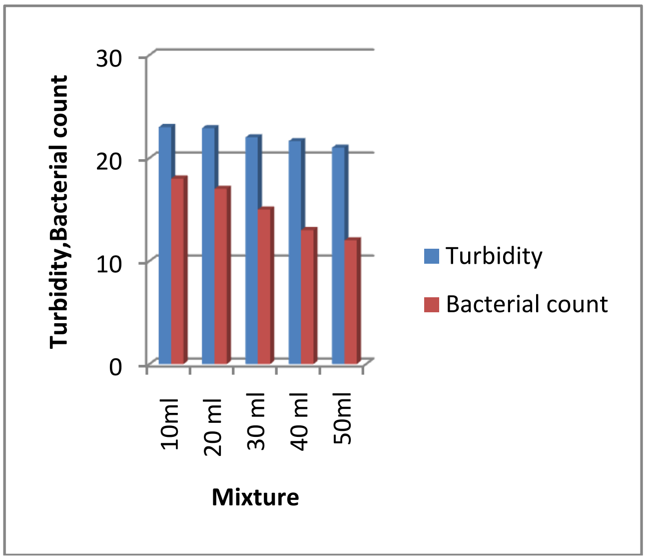


Fig: 8 Mixture of 600 gm stream water + 4 gm M.O Powder

Efficiency of turbidity removal for *M.* oleifera in 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 600 mg/L of 4g powdered coagulant . Above a coagulant dose of 50ml per 600 ml sample volume, efficiency was high removal in 21 at turbidity and 12 at bacterial count.

Table: 9 Mixture of 600 ml Stream water + 6g M.O Powder

Mixture	Turbidity	Bacterial count
10 ml	21	11
20 ml	20.42	10
30 ml	18.85	8
40 ml	17.36	7
50ml	16	6

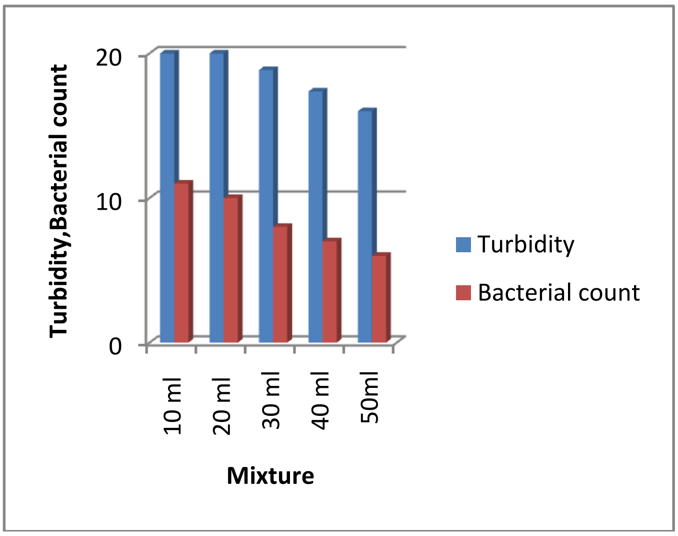


Fig: 9 Mixture of 600 gm stream water + 6 gm M.O Powder

Efficiency of turbidity removal for *M.* oleifera in 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 600 mg/L of 6g powdered coagulant . Above a coagulant dose of 50 ml per 600 ml sample volume, efficiency was high removal in 16at turbidity and 6 at bacterial count.

Table: 10 Mixture of 200 ml Stream water + 2g Alum

Mixture	Turbidity	Bacterial count
10ml	58	62
20 ml	57.6	62
30 ml	56.3	61
40 ml	55.8	60
50ml	55	59

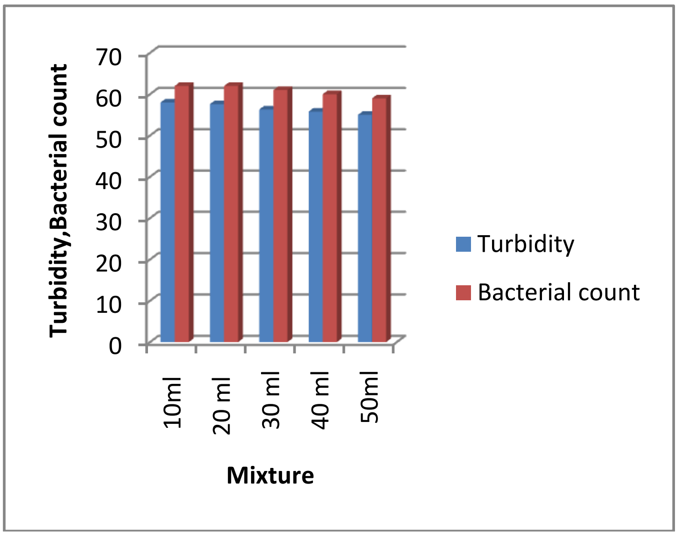


Fig: 10 Mixture of 200 gm stream water + 2gmAlum

Efficiency of turbidity removal for Alum *in* 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 200 mg/L of 2g coagulant. Above a coagulant dose of 50 ml per 200 ml sample volume, efficiency was high removal in 55 at turbidity and 59 at bacterial count.

Table: 11 Mixture of 200 ml Stream water + 4gAlum:

Mixture	Turbidity	Bacterial count
10ml	55	59
20 ml	54.39	58
30 ml	53.8	56
40 ml	52	55
50ml	51.7	54

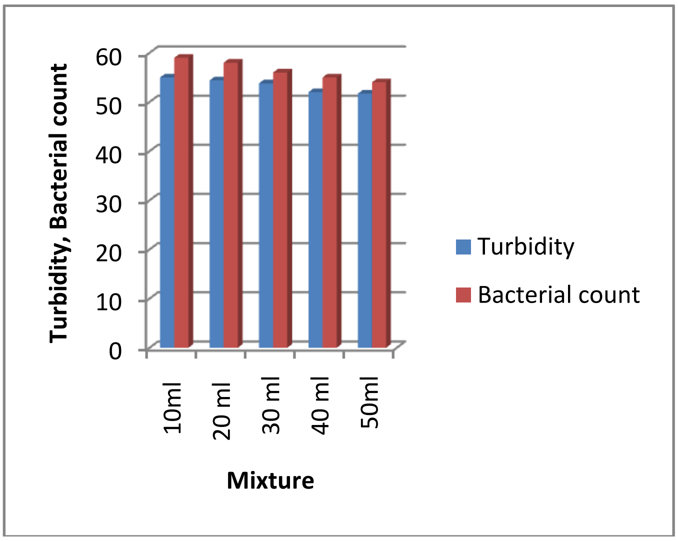


Fig: 11 Mixture of 200 gm stream water + 4gmAlum

Efficiency of turbidity removal for Alum in 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 200 mg/L of 4g coagulant. Above a coagulant dose of 50 ml per 200 ml sample volume, efficiency was high removal in 51.7at turbidity and 54 at bacterial count.

Table: 12 Mixture of 200 ml Stream water + 6g Alum:

Mixture	Turbidity	Bacterial count
10 ml	50.35	54
20 ml	49.7	52
30ml	49	52
40 ml	48.27	51
50ml	47.53	50

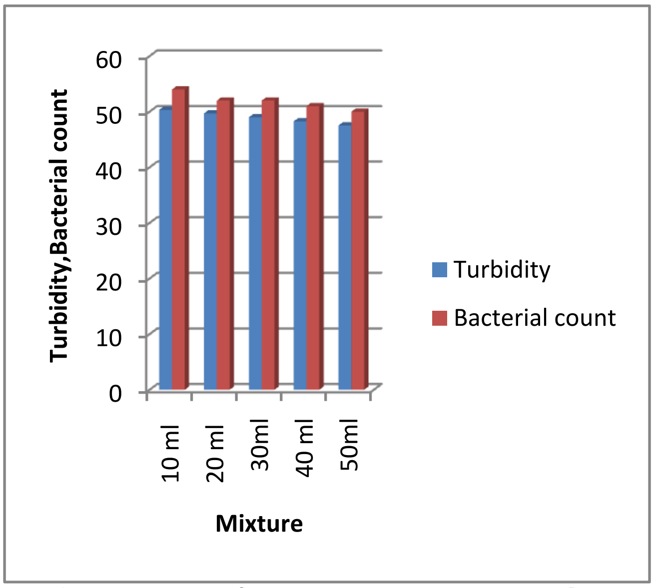


Fig: 12 Mixture of 200 gm stream water + 6gmAlum

Efficiency of turbidity removal for Alum *in* 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 200 mg/L of 4g coagulant. Above a coagulant dose of 50 ml per 200 ml sample volume, efficiency was high removal in 47.53at turbidity and 50 at bacterial count.

Table: 13 Mixture of 400 ml Stream water + 2g Alum:

Mixture	Turbidity	Bacterial count
10 ml	47	49
20ml	46.4	48
30 ml	44	46
40 ml	43.32	46
50ml	42.8	45

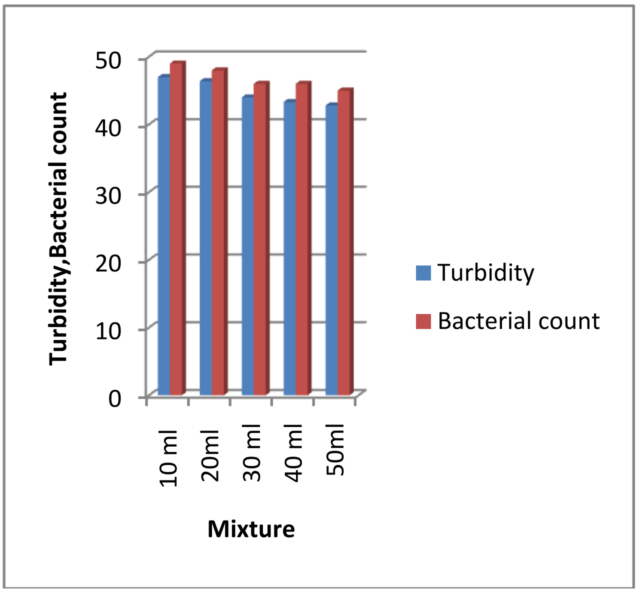


Fig: 13 Mixture of 400 gm stream water + 2gmAlum

Efficiency of turbidity removal for Alum in 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 200 mg/L of 6g coagulant. Above a coagulant dose of 50 ml per 200 ml sample volume, efficiency was high removal in 55 at turbidity and 59 at bacterial count.

Table: 14 Mixture of 400 ml Stream water + 4g Alum:

Mixture	Turbidity	Bacterial count
10 ml	42	45
20 ml	40.6	44
30 ml	40	42
40 ml	39.4	41
50ml	38	40

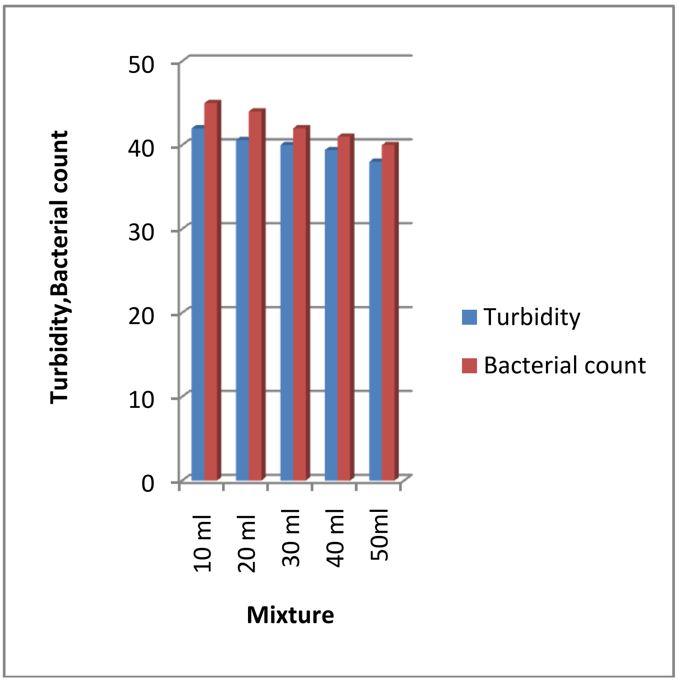


Fig: 14 Mixture of 400 gm stream water + 4gmAlum

Efficiency of turbidity removal for Alum *in* 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 400 mg/L of 4g coagulant. Above a coagulant dose of 50 ml sample volume, efficiency was high removal in 38at turbidity and 40 at bacterial count.

Table: 15 Mixture of 400 ml Stream water + 6g Alum

Mixture	Turbidity	Bacterial count
10 ml	31	32
20 ml	30.4	30
30 ml	29.53	28
40 ml	28.44	26
50ml	28.27	25

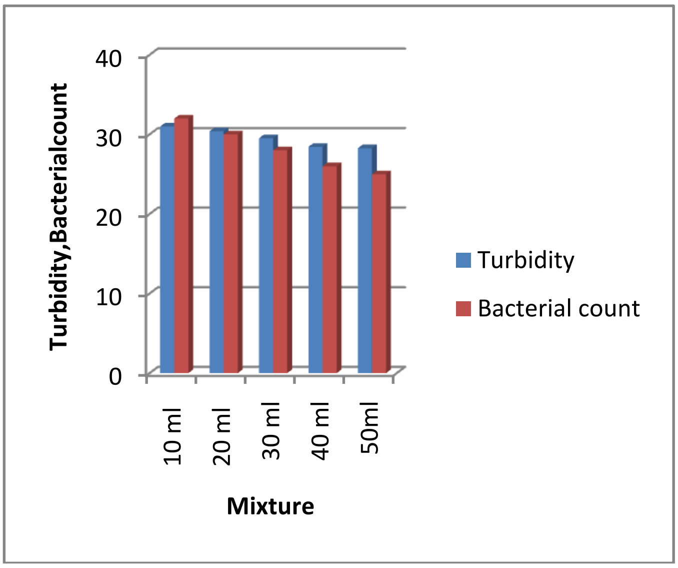


Fig: 15 Mixture of 400 ml Stream water + 6gAlum

Efficiency of turbidity removal for Alum *in* 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 400 mg/L of 6g coagulant. Above a coagulant dose of 50 ml sample volume, efficiency was high removal in 28.25 at turbidity and 25 at bacterial count

Table: 16 Mixture of 600 ml Stream water + 2gAlum:

Mixture	Turbidity	Bacterial count
10ml	27	24
20 ml	26.8	22
30 ml	25	22
40 ml	24.32	20
50ml	23.69	18

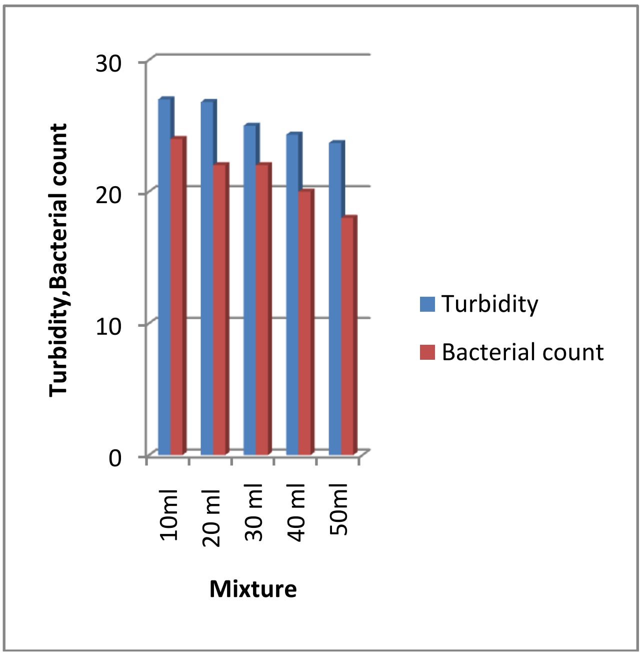


Fig: 16 Mixture of 600 gm stream water + 2gmAlum

Efficiency of turbidity removal for Alum *in* 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 600 mg/L of 2g coagulant. Above a coagulant dose of 50 ml sample volume, efficiency was high removal in 55 at turbidity and 59 at bacterial count.

Table: 17 Mixture of 600 ml Stream water + 4g Alum:

Mixture	Turbidity	Bacterial count
10ml	23	18
20 ml	22.9	17
30 ml	22	15
40 ml	21.64	13
50ml	21	12

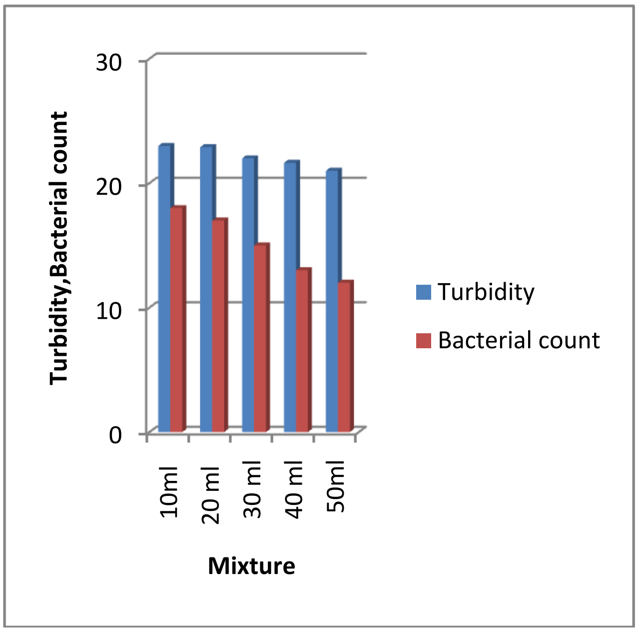


Fig: 17 Mixture of 600 gm stream water + 4gmAlum

Efficiency of turbidity removal for Alum *in* 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 600 mg/L of 4g coagulant. Above a coagulant dose of 50 ml sample volume, efficiency was high removal in 55 at turbidity and 59 at bacterial count.

Table: 18 Mixture of 600 ml Stream water + 6gAlum:

Mixture	Turbidity	Bacterial count
10 ml	21	11
20 ml	20.42	10
30 ml	18.85	8
40 ml	17.36	7
50ml	16	6

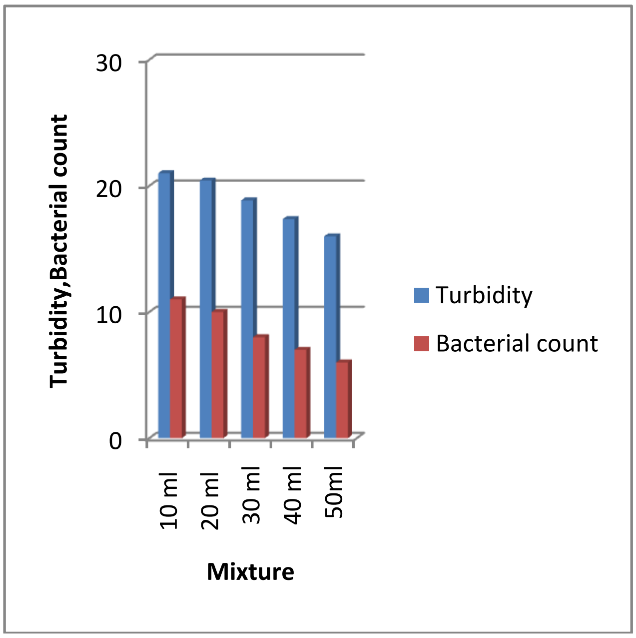


Fig: 18 Mixture of 600 ml Stream water + 6gAlum

Efficiency of turbidity removal for Alum *in* 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 600 mg/L of 6g coagulant. Above a coagulant dose of 50 ml sample volume, efficiency was high removal in 55 at turbidity and 59 at bacterial count.

Table: 19 Mixture of 200,400, 600 ml Stream water + 6g M.O IN 30 min

Mixture	Turbidity	Bacterial count
50 ml	37	34
50 ml	18	20
50ml	16	3

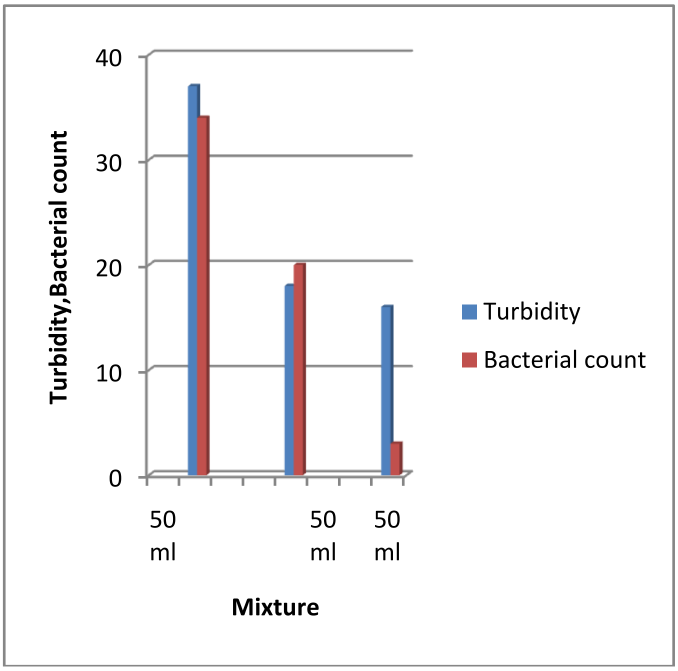


Fig: 19 Mixture of 200,400,600 gm stream water + 6gm M.O in 30 min

In the time interval of 30 min, efficiency of turbidity removal for M.O in 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 600 mg/L of 6g coagulant. Above a coagulant dose of 50 ml sample volume, efficiency was high removal in 16 at turbidity and 3 at bacterial count.

Table: 20 Mixture of 200,400, 600 ml Stream water + 6g ALUM IN 30 min:

Mixture	Turbidity	Bacterial count
50 ml	42.53	46
50 ml	29.23	30
50 ml	20	10

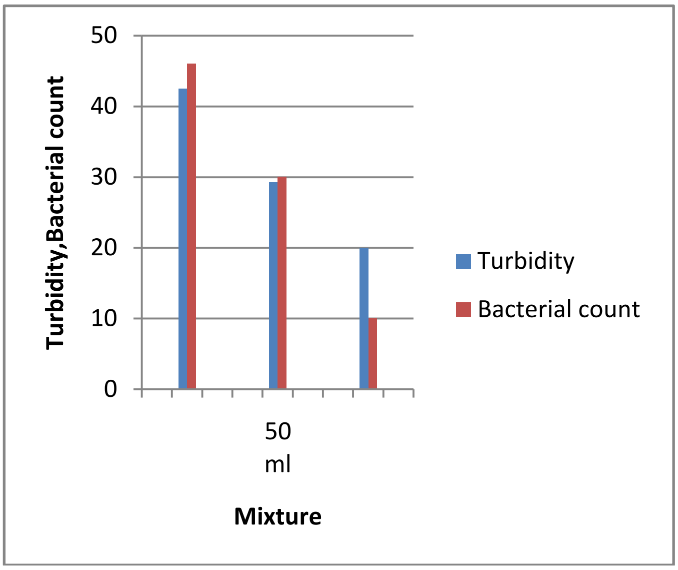


Fig: 20 Mixture of 200,400,600 gm stream water + 6gm ALUM in 30 min

In the time interval of 30 min, efficiency of turbidity removal for Alum *in* 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 600 mg/L of 6g coagulant. Above a coagulant dose of 50 ml sample volume, efficiency was high removal in 20 at turbidity and 10 at bacterial count

Table: 21 Mixture of 200,400, 600 ml Stream water + 6g M.O IN 40 min:

Mixture	Turbidity	Bacterial count
50 ml	29	18
50 ml	9.28	10
50 ml	5	0

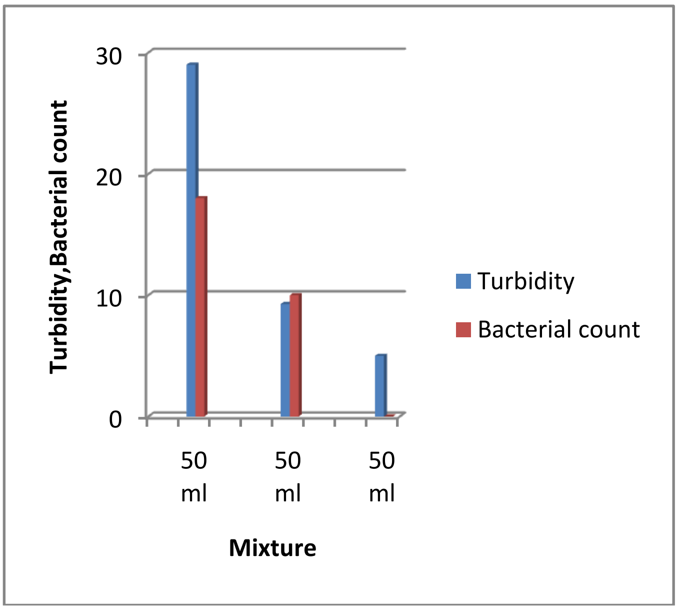


Fig: 21 Mixture of 200,400,600 gm stream water + 6gm M.O in 40 min

In the time interval of 40 min, efficiency of turbidity removal for M.O in 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 600 mg/L of 6g coagulant. Above a coagulant dose of 50 ml sample volume, efficiency was high removal in 5 at turbidity and Nil at bacterial count.

Table: 22 Mixture of 200,400, 600 ml Stream water + 6g Alum IN 40 min

Mixture	Turbidity	Bacterial count
50 ml	37	38
50 ml	17.6	20
50 ml	14	6

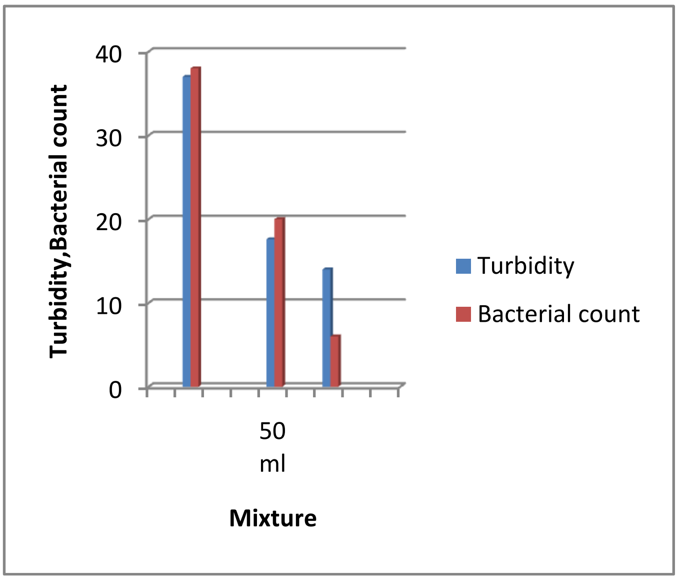


Fig: 22 Mixture of 200,400, 600 ml Stream water + 6g Alum

In the time interval of 30 min, efficiency of turbidity removal for Alum *in* 10, 20, 30, 40 and 50ml dose of stock solution per 1000 ml sample volume corresponds to a concentration of 600 mg/L of 6g coagulant. Above a coagulant dose of 50 ml sample volume, efficiency was high removal in 14 at turbidity and 6 at bacterial count.

4. SUMMARY AND CONCLUSION

4.1 Summary:

In this phase, water was collected from Palakkarai stream at specified sites. Various Characteristics was analysed at Environmental Engineering laboratory, Moringa Oleifera seed Powder and Kernel powders were prepared and analysis for turbidity removal and bacterial count for different time level. Turbidity removal efficiency of *Moringa* oleifera was found to increase with increasing dosage. The Moringa oleifera is more effective than Alum.

Moringa oleifera has potential to be used in the treatment of stream waters for domestic use in tropical developing countries.

4.2 Conclusions:

This preliminary investigation of the coagulation efficiency of *M.* oleifera extract shows promise with respect to overall turbidity removal and Total Coliform reduction and substantiates the findings of previous investigators. At the estimated equivalency dose based on applied coagulant mass, comparable removal of turbidity was achieved to that of alum and was on the order of 95% or greater; however, total coliform reduction was not as efficient. Both coagulants exhibited considerable variation in total coliform counts among the six experiments conducted at the equivalency dose. Average reduction was 77%versus 89%, respectively, for *M.* oleifera and alum. The powdered *M.oleifera* seeds substantially improve overall coagulation efficiency.

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