# EFFICACY OF SAND FILTRATION, MORINGA OLEIFERA SEED AND ALUM TREATMENT IN REDUCTION OF COLIFORMS AND TOTAL BACTERIA IN STABILIZATION POND EFFLUENT

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# EFFICACY OF SAND FILTRATION, *Moringa oleifera* SEED AND ALUM TREATMENT IN REDUCTION OF COLIFORMS AND TOTAL BACTERIA IN STABILIZATION POND EFFLUENT

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## Abstract

**Objectives** A slow sand filter was designed and constructed with decreasing sizes of sand layers. Granulations were made out of the seeds of *Moringa oleifera.* Their turbidity clarification, coliform and total bacteria reduction were tested. Their abilities to reduce the densities of *Salmonella typhi, Bacillus cereus, Shigella dysenteriae, Escherichia coli* in waste water were also tested. Coliform number reduction was 78% by sand filtration, 78% alum treatment and 98% by *M. oleifera* ground seed treatment. The sand filter reduced total bacteria population by 4%, alum and *M. oleifera* treatments by 33% and 84% respectively. There was a 12% reduction in *Shigella dysenteriae* numbers by the slow sand filter, 57% reduction by alum and 76% reduction *Moringa oleifera* treatment. Sand filtration reduced *Salmonella typhi* population by 29%, alum and *Moringa oleifera* treatments did so by 43% and 71% respectively. *Escherichia coli* numbers were reduced by 10% by sand filtration, 27% by alum treatment and 56% by *M. oleifera* treatment. *Bacillus cereus* population was reduced by 9% by both sand filtration and alum treatment while *Moringa oleifera* application gave a 32% reduction. *M. oleifera* ground seed treatment was the best at coliform population reduction (98% reduction) of the three treatments. Sand filtration and alum treatment were found to be equal in coliform reduction rate since they both reduced coliform numbers by 78%.

*M. oleifera* treatment was the most efficient in total bacteria population reduction, with an 84% reduction rate. Slow sand filtration was most effective on *S. typhi* (29% reduction) of the four organisms tested.

**Keywords**: : Sewage; Sand filter; *Moringa oleifera* seeds; Alum

## Introduction

Sewage are human and domestic waste water from buildings, residential and industrial, that are carried away through sewers. Aluminum sulphate is mainly used as a flocculating agent in the purification of drinking water and waste water treatment plants. It is necessary that both water and wastewater technology for developing countries must be no more complex than strictly necessary, be robust and cheap to install and maintain. Preliminary studies on the active ingredient of *Moringa oleifera* as a coagulant have suggested that the active components are cationic peptides of molecular weight ranging from 6 to 16 kilodalton and isoelectric pH value of 10 [2].Sand filtration is one of the oldest wastewater treatment technologies known. If properly designed, constructed, operated and maintained, a sand filter produces a very high quality effluent [3]. A sand filter purifies the water in three ways namely;

Filtration, Chemical adsorption and Assimilation [3].

The objectives of this experiment therefore are to design a pilot-scale sand filter, obtain the percent reduction of coliforms, total bacteria and specific bacteria in sewage water by sand filtration, alum and *Moringa oleifera* seed treatment.

## Materials and Methods

### Collection and Preparation of Coagulants (Plant Material and Aluminum Sulphate).

The plant material used for this study which are *Moringa oleifera* seeds were collected in December 2010 from an identified and labeled *Moringa oleifera* tree at Professor Olu Odeyemi's Farm and Forest Reserves. The seeds were gathered, allowed to dry, dehulled and granulated. Aluminum sulphate, commonly referred to alum, was obtained from a local retailer.

### Waste Water Source.

The waste water used was sourced from the sewage oxidation pond at Obafemi Awolowo University, Ile-Ife.

### Sand Filter Design.

Three sets of two types of sand filters were set-up; the experimental and control sand filters. Impervious, crystalline stones of varying sizes were collected, sterilized in dry oven at $140^0$C for 2 hours, allowed to cool and arranged in descending order in a sterile polyethylene terephthalate (PET) bottle.

### Determination of Average Flow Rate of Sewage Water through the Sand filters.

Waste water was poured into the sand filter and the volume eluted in 15minutes was taken. The flow rate is taken as ml/sec.

### Determination of the Percent Reduction of Coliforms by Sand filtration.

### The Multiple Tube Technique.

Culture & Media:

Water sample obtained from sewage oxidation pond, OAU. Lactose broth prepared into single and double strengths.

Procedure

Three separate series of 3 test tubes were set up in a test tube rack and for each tube the strength of broth and volume of sample inoculated were marked on as stated by standard MPN procedure. Sewage plant water was thoroughly mixed and introduced into the prepared tubes as labeled. The tubes (with inverted Durham tubes) were incubated for 48hrs.

This was repeated after sand filtration and the most probable number (MPN) of the coliforms in 100ml computed on the basis of the various combinations of positive and negative results vis-a-vis standard tables.

### Determination of the Per cent Reduction of Coliforms by Coagulation with Aluminium Sulphate and M. oleifera Seed Powder Only.

1.00g of both coagulants was introduced into 1 litre of the raw effluent separately and their maximum retention time taken to be 15 minutes. The MPN & turbidity (in ABS) values were taken before and after the treatments. A control container was set up with only the raw effluent and no coagulant added.

### Serial Dilution Assay of Raw Sewage, Sand-Filtered, Alum and M. oleifera Coagulation Supernatant for Total Bacteria and Specific Organisms.

Tubes of sterile water were labelled A-F. Using the sterile water and separate test tubes, serial dilutions of the samples were done. Using separate sterile pipettes, 1 ml of cell suspension (A-F) was withdrawn into petridishes of molten agar. The plates were mixed and incubated at $35^o$C. This was done for the four samples of raw sewage, sand filtered and supernatant from coagulation.

### Collection and Identification of Sewage-Associated Microorganisms.

Isolates of *Salmonella typhi*, *Bacillus cereus*, *Shigella dysenteriae*, *Escherichia coli* were collected by selective media and identified from the raw untreated waste water. Appropriate morphological and

biochemical tests were carried out to ascertain their identities.

## Results

### Flow Rate of Waste Water through the Sand filters.

Average flow rate through experimental sand filters =28.3ml/15mins = 0.03ml/sec
Flow rate for control sand filter = 0.5ml/sec.

### Reduction of Coliforms in Sewage by Sand filtration and Coagulation.

Before filtration, most probable number of 1100+ coliform cells /100ml of the raw sewage water sample was obtained. After sand filtration, a most probable number of 240 coliform cells /100ml of the filtrate resulted. After coagulation with Alum, MPN was 240cfu/100ml. After coagulation with *Moringa oleifera*, MPN was 23cfu/100ml.

**Percentage reduction = $\frac{Mr - Mt}{Mr} \times 100$**

Where: **Mr** is MPN of raw waste water

**Mt** is MPN of treated waste water

### Reduction of Total Bacteria in Sewage Water by Sand filtration and Coagulation.

The numbers of colony forming units present in the raw sewage and control filtrate were 240000 and 260000 cfu/ml respectively. After slow sand filtration, the numbers fell to 230000, indicating a 4% reduction. After Alum and *M. oleifera* seed powder treatments, the numbers reduced to 160000 and 39000 respectively i.e 33% and 84% reduction respectively.

### Reduction of Specific Bacteria in Sewage Water by Sand filtration and Coagulation.

Figures 1 & 2 show results of indirect cell counts on the test organisms namely; *Salmonella typhi, Bacillus cereus, Shigella dysenteriae* and *Escherichia coli*. Selective media used in their isolation were Deoxycitrate agar (DCA), Blood agar and MacConkey agar. From Figure 2, there was 12% reduction in *Shigella dysenteriae* numbers after sand filtration, 57% and 76% reduction after alum and *M. oleifera* coagulation respectively. From Figure 2 also, there was 29% reduction in *Salmonella typhi* numbers after sand filtration, 43% and 71% reduction after alum and *M. oleifera* coagulation respectively. There was 10% reduction in *Escherichia coli* numbers after sand filtration, 27% and 56% reduction after alum and *M. oleifera* coagulation respectively. *Bacillus cereus* numbers reduced by 9% after sand filtration, 9% after alum coagulation; and 32% after *Moringa oleifera* seed powder application.

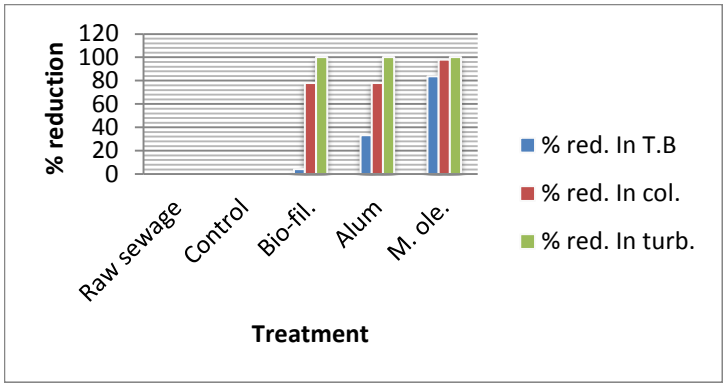


Fig. 1: Per cent reduction in total bacteria, coliform number and turbidity.

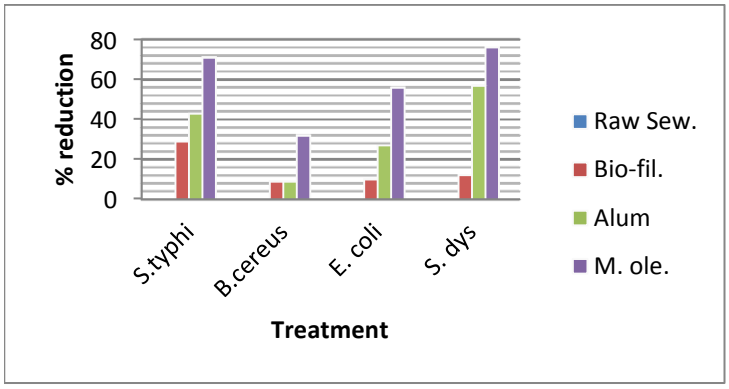


Fig. 2: Per cent reduction of test organisms in sewage.

## Discussion

From fig.1, both sand filtration and alum coagulation reduced turbidity from 0.01ABS to 0.00ABS and coliform numbers from 1100cfu/100ml to 240cfu/100ml. However, alum coagulation proved more efficient in reduction of total microbial numbers in the raw sewage, reducing it by 33% (from 240000cfu/ml to 39000cfu/ml). Crushed seeds of *M. oleifera* were most effective in reducing total bacteria (Fig. 1) and coliform numbers; with an 84% and 98% reduction respectively. This is even better than what was obtained with alum (33% and 78% respectively) and since it is easy and relatively cheap to obtain, it could serve as a viable replacement for alum in industrial waste water treatment.

Slow sand filtration reduced *Salmonella typhi* numbers by 29% (Fig.2) and thus making *S. typhi* the most susceptible to sand filtration among the tested organisms. This may be due to its possession of capsules, thus increasing its mass hence getting easily trapped in the spaces between the sand particles. *Moringa oleifera*'s crushed seeds displayed excellent results in reduction of the numbers of *S. typhi, B. cereus, E. coli,* and *S. dysenteriae;* with a reduction of 71%, 32%, 56% and 76% respectively; as opposed to 43%, 9%, 27% and 57% respectively obtained with alum coagulation. *M. oleifera's* seed powder floated on the waste water on expiration of the maximum retention time (15minutes). This property could be useful in reclamation and reuse of the crushed seeds.

## Conclusion and Recommendations.

This pilot scale study has demonstrated the effectiveness of slow sand filtration and *M. oleifera* seed powder in turbidity clarification and microbial population reduction of waste water. The use of *M. oleifera* as a coagulant in

treatment of industrial effluent thus should be encouraged. The growth of *M. oleifera* trees by small hold farmers should be promoted. A departure from alum use would not only be economically advantageous, but also eco-friendly. Also, slow sand filters, as demonstrated in this research, are easy to construct, from naturally available materials, and should be incorporated as a central component of waste water treatment domestically and industrially.

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