Experimental Study on Recycling and Reuse of Greywater through Filetration Technique

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Abstract

The use of natural plant extracts for treatment of water in some parts of the world has been recorded throughout human history. An example is the use of Moringa oleifera in water purification due to its coagulation properties. However, the efficiency of the treatment systems largely depends on the design of the system and its operation. The aim of this study was to investigate the efficiency of Moringa oleifera seed powder coupled with sand filtration in treating greywater from Nagpur institute of technology in girls hostel.

A water extract from the seeds of M. oleifera was applied to the treatment sequence of coagulation–flocculation–sedimentation, followed by charcoal filtration. Moringa oleifera seed powder was added to raw greywater and then filtered through a sand filter bed.
In this study, the integration of M. oleifera seed suspension with charcoal filter showed a lot of potential in terms of water treatment with respect to bacteriological quality.

Total coliforms were significantly reduced by 92.36% while fecal coliforms were significantly reduced by 99.23% with a p-value of 0.003 in a combined treatment of Moringa oleifera and charcoal filter. The integrated treatment also reduced BOD of river water by 50.66%. The M. oleifera integrated charcoal filter system if carefully studied and implemented could clarify all types of turbid and wastewater.

It is also expected that a 100% disinfection rate, faster flow rates and shorter residence time with little clogging and backwashing of filter may be the potentials of this hybrid system.

Key Word : Gray water treatment, Reuse of gray water, Filetration using Moringa oleifera seed and activated charcoal filter using microbiological parameters.

1.Introduction

Potable water is an essential component or need for a healthy living. Safe water, adequate sanitation and proper nutrition are essential health needs to be met in the developing and the developed nations. However, over one billion people have no access to safe drinking water globally , while 2.6 billion people lack adequate sanitation leading to deaths of 1.8 million people every year from water related diarrheal diseases. Among this population it has been reported that 90% of children under the age of five years, are mainly from developing countries. Water from unprotected sources is usually turbid and contaminated with microorganisms that cause many diseases. Water borne diseases are one of the main problems in developing countries. Serving the world with adequate safe drinking water and sanitation is an important prerequisite to hygienic safety, prosperity and political stability. The conventional method of water purification using aluminum sulphate (alum) and calcium hypochlorite exerts pressure on nations' over-burdened financial resources since they are imported thereby making treated water very expensive in most developing countries and beyond the reach of most rural folks. The use of alternative, non-conventional, relatively cheap, sustainable and readily available water purification methods could be the most suitable intervention for developing countries.

In many developing countries, chemical coagulants, such as aluminium sulphate and synthetic poly-electrolytes are usually unavailable. Moringa tree seeds, when crushed into powder, can be used as a water-soluble extract resulting in an effective natural clarification agent for highly turbid and untreated pathogenic surface water. Besides improving water drinkability, this technique reduces water turbidity (cloudiness) resulting in water being both aesthetically as well as microbiologically more acceptable for human consumption .The application of this low cost Moringa oleifera seeds is recommended for eco-friendly, nontoxic, simplified water treatment for rural and peri-urban people living in extreme poverty.

1.1 Information About Project

Grey water reuse is one of such strategy, and its usefulness to fulfill non-potable water needs is being thoroughly investigated by researchers. Grey water is wash water coming from showers, bathtubs, washing machines and bathroom sinks. However, many households in poorer areas lack access to fertilizers and have a limited supply of fresh water. Wastewater treatment and reuse at the individual level can provide a combined solution to these problems by supplying the water and nutrients needed for household food production. these problems by supplying the water and nutrients needed for household food production. Indeed, this strategy is already in use by millions of farmers worldwide and it is estimated that 10% of the world's population consumes foods irrigated with wastewater. Wastewater treatment and reuse for irrigation may well hold the key to easing demand on limited freshwater reserves while improving the food production capacity of households and farms.The cost involved in achieving the desired level of treatment depends, among other things, on the cost and availability of chemicals. Chemicals commonly used for the various treatment units are synthetic organic and inorganic substances. In many places these are expensive and they have to be imported in hard currency. Many of the chemicals are also associated with human health and environmental problems. In general Moringa oleifera seed (MO) is increasingly being recognized as a cheap substitute for wastewater treatment and is safe for human health.

1.2 Statement Of Problem

Untreated wastewater is commonly used in urban irrigated vegetable farming. The wastewater is obtained from urban streams, shallow ponds and drains which are sources of irrigation for farmers. Most urban centres have no means of treating wastewater and only 4.5% of households in Ghana are connected to sewer networks. This leaves most untreated wastewater (grey water), mainly from domestic sources, ending up in urban drains and water bodies in and downstream of the cities. The use of wastewater in vegetable farming leads to the transmission of pollution-related diseases affecting human health. Transmission of diseases, mainly bacterial and intestinal nematode infections, occurs through eating of produce from wastewater irrigated fields. High levels of turbidity in irrigation water restricts the use of better irrigation methods like drip irrigation and filtration techniques such as slow sand filters that can greatly reduce contamination as they become easily clogged. Measures to improve water quality should be simple and low-cost for easy adoption by urban vegetable farmers as they cannot afford high-cost wastewater treatment.

1.3 Justification

The most widely applied water treatment technology, a combination of some or all of coagulation, flocculation and sedimentation, plus filtration, has been used routinely for water treatment since the early part of the twentieth century. Coagulation is a simple and
inexpensive way to improve the quality of water and reduces levels of organic compounds, dissolved phosphorus, colour, iron, and suspended particles. Up to 70% of Chemical Oxygen Demand (COD) in municipal wastewater is attributable to particulate matter larger than 0.45μm. Several pollutants are also incorporated into, or adsorbed onto, the particulate material. Thus, it is of interest to explore the development of a treatment strategy for the enhanced removal of suspended and colloidal solids from wastewater.

Chapter 2

2. LITERATURE REVIEW

Greywater recycling methods can be broken down into three categories: physical, biological, and chemical. Physical filtration processes leverage characteristics of the greywater such as particle size and weight, making them most effective at removing large particulates and reducing turbidity. Sedimentation, which removes the heaviest solids from incoming greywater, is typically placed at the beginning of the water filtration process.Another common method of physical filtration is membrane filtration, which removes particulates on the basis of size. The efficiency of membrane filters is dictated by the size of their pores, which range from macroscale to nanoscale. A drawback of physical filters is that they must be periodically backwashed, cleaned, or replaced due to fouling, which incurs financial and time costs for maintenance.

2.1 PHYSICOCHEMICAL QUALITY OF TREATED GRAY WATER

Chemical filtration techniques induce chemical changes in the pollutants through the addition of various chemicals. Chemical disinfection mechanisms are typically placed at the end of filtration systems to kill remaining microorganisms and prevent regrowth, as they do not remove particulates and other pollutants.The placement of disinfection at the end of filtration is strategic because the greywater has already been purged of particulate matter that would otherwise shield microorganisms.The most common chemical disinfection technique is chlorination. The use of chlorination must be controlled because excessive residual chlorine can be hazardous to human health.

A potentially safer option is ultraviolet disinfection, which uses UV light to kill microorganisms without altering other water quality parameters. UV disinfection does not require the synthesis, transportation, and consumption that chlorine does, making UV disinfection more environmentally friendly. Another chemical filtration method, coagulation, can be implemented earlier in filtration systems, working in conjunction with physical treatments. Coagulants can be added to inlet greywater to cause pollutants to stick together, forming large masses that can be more easily removed via physical filtration.Despite the effectiveness of chemical filtration techniques, they must be used with caution to avoid dosing the water beyond levels that the filtration system can safely handle.

A number of studies indicate that a natural coagulant from the Moringa oleifera seed (MO) may be an alternative for metal salts . Using Moringa instead of aluminium sulphate might give many advantages, such as smaller costs and less sludge production (Ndabigengesere and Narasiah, 1998). However, there are also some disadvantages often connected with the use of Moringa, i.e. increased concentration of nutrients and COD.

2.1.1 Biological Filtration

Biological filtration techniques use microorganisms to improve the quality of wastewater by consuming most organic and some inorganic pollutants in the water. Biological filtration methods are infrequently used on their own, as they are usually preceded by sedimentation or screening and followed by chemical filtration because both biological and chemical filtration require low turbidity to effectively kill pathogens. Examples of biological filtration technologies include biosand filters and trickling filters. Biosand filters consist of a traditional sand filter with a bacterial layer on top, called a biofilm . The sand acts as an additional physical filter, while the bacterial layer decomposes organic matter. Biosand filters can remove organics and solids that were not removed by previous filters.Trickling filters enable organic pollutants to be decomposed by microorganisms in a biofilm.Trickling filters typically require periodic maintenance and may develop an odor due to solids buildup over time.

2.1.2 Turbidity

The cloudiness of water is referred to as turbidity and has its origin from particles suspended in the water.These are natural contaminants and most often consist of mineral particles such as clay and silt or organic flocs. Turbidity is a major problem in water treatment when the water source is surface water but can often be neglected in treatment of groundwater . Turbidity is usually measured in Nephelometric Turbidity Units (NTU). This is an optical measurement, where a light beam is transmitted through the water sample, and 10 the amount of scattered and absorbed light is detected.

2.1.3 Organic Content – Chemical Oxygen Demand (COD)

The taste and smell of the water is affected by the amount of organic compounds in the water. The organic content comes from both natural and anthropogenic sources and is often expressed as chemical oxygen demand (COD). COD is a measurement of the amount of oxygen it takes to degrade the oxidizable, mainly organic content of the water, and is expressed in mgO_2/l .

2.2 WATER QUALITY

Often, the limits on concentrations of many chemicals in wastewater will be determined by crop requirements and not by health concerns . The nutrients in wastewater (i.e., nitrogen, potassium, phosphorus, zinc, boron and sulphur) should be present in the right concentrations or they can damage the crops and/or the environment. For example, wastewater often contains high concentrations of nitrogen. Although plants require nitrogen for growth, excessive nitrogen can cause over-stimulation of growth, delayed maturity or poor quality produce. Plants require different amounts of nitrogen based on the stage of growth. In the first stages of growth plants may require high quantities of nitrogen (in the earliest stages of growth plants require lots of nitrogen but may be too small to usefully assimilate all that is applied), but in the later flowering and fruiting stages they may require less. In some cases nitrogen levels will need to be adjusted by blending water supplies . This is also an important consideration to reduce leaching of nitrate into groundwater supplies and posing a potential health risk to consumers of the drinking water. Sodium chloride, boron and selenium should be monitored carefully. Many plants are sensitive to these substances. Boron is frequently present in wastewater because it is used in household detergents. Many types of trees (e.g., citrus and stone fruits) will 15 have impaired growth even when low boron concentrations are present in the water.

2. 2.1 Primary treatment

Primary treatment is achieved in sedimentation tanks with a retention time of approximately 2−6 hours. Pathogen reduction is minimal, generally <1 log unit. However, where wastewaters have high helminth egg numbers, primary treatment can remove substantial numbers of eggs even though the reduction is <1 log unit.

Chemically enhanced primary treatment

The pathogen reduction efficiency of primary treatment can be increased by incorporating coagulation/flocculation upstream, and/or by using filtration downstream of, gravity sedimentation . Chemically enhanced primary treatment (CEPT), also called advanced primary treatment (APT), uses specific chemicals (e.g., lime or ferric chloride often with a high-molecularweight anionic polymer) to facilitate particle coagulation and flocculation. Improving Additionally many virus particles are associated with particulate matter (suspended solids) and CEPT increases suspended solids removal from approximately 30 percent to 70−80 percent . Another advantage is that nitrogen, organic matter and phosphorus are only partially removed.

2. 2.2 Secondary Treatment

Secondary treatment systems, which follow primary treatment, are biological treatment processes coupled with solid/liquid separation. The biological processes are engineered to provide effective bio-oxidation of organic substrates dissolved or suspended in the wastewater. Secondary treatment processes comprise an aerobic microbial reactor followed by secondary sedimentation tanks to remove and concentrate the biomass produced from the conversion of wastewater organic constituents. The aerobic reactors use either suspended-growth processes (e.g., activated sludge, aerated lagoons, oxidation ditches) or fixed-film processes (trickling filters, rotating biological contactors). Although secondary treatment systems are designed primarily for the removal of BOD.

2.2.3 Tertiary Treatment

Tertiary treatment refers to treatment processes downstream of secondary treatment such as (a) additional solids removal by flocculation, coagulation and sedimentation, and/or granular medium filtration; and (b) disinfection. When tertiary treatment processes are used, the overall sequence of wastewater treatment processes is generally described as "advanced wastewater treatment".

First, different parameters of the gray water collected were tested. They are as follows:-

Parameter	Value
pH	9.8
TDS	23.2gm/L
TSS	3.52gm/L
BOD5	130mg/L
Alkalinity	1225mgCaCo3/L
Turbidity	12NTU
Sulphate	3mg/L

Table (1) : Parameter Of Gray Water

Chapter 3

IDENTIFICATION OF PROBLEM

3.1 PROBLEM ANALYSIS

Untreated wastewater is commonly used in urban irrigated vegetable farming .The wastewater is obtained from urban streams, shallow ponds and drains which are sources of irrigation for farmers. Most urban centres have no means of treating wastewater and only 4.5% of households in Ghana are connected to sewer networks .This leaves most untreated wastewater (**gray water**), mainly from domestic sources, ending up in urban drains and water bodies in and downstream of the cities.

The use of wastewater in vegetable farming leads to the transmission of pollution-related diseases affecting human health. Transmission of diseases, mainly bacterial and intestinal nematode infections, occurs through eating of produce from wastewater irrigated fields and 4 through direct contact by farmers and other field workers. High levels of turbidity in irrigation water restricts the use of better irrigation methods like drip irrigation and filtration techniques such as slow sand filters that can greatly reduce contamination as they become easily clogged.

Measures to improve water quality should be simple and low-cost for easy adoption by urban vegetable farmers as they cannot afford high-cost gray water treatment.

3.2 OBJECTIVES

3.2 .1 General Objective

The focus of this study is the treatment of wastewater for use in irrigated urban vegetable farming by using Moringa oleifera seed powder.

3.2 .2 Specific Objectives

(i) To test the efficacy of treatment of wastewater with Moringa oleifera as a natural coagulant.

(ii) To determine the conditions for the optimum performance of Moringa oleifera in treating polluted water (conductivity, pH, turbidity, removal of faecal coliforms etc).

(iii) To assess the effectiveness of Moringa oleifera in reducing pollution levels in surface water in actual field conditions.

3.2 .3 Output

Effective conditions for wastewater treatment using Moringa oleifera seed will be established.

- These objectives will be realized through:

  testing of water quality parameters of raw and treated water

- determination of optimum dosage of Moringa oleifera for different levels of turbidity, and its

  Removal efficiency
- investigating the possibilities of using Moringa oleifera in reducing pollution in surface water in actual farm conditions.

4 Methodology
4.1 Sampling And Sample Preparation

Glass sample bottles were sterilized in an autoclave at 121°C for 15 minutes. A sample of 1.5 litres of water was fetched from each of the four streams i.e sand, aggregate, charcoal, and moringa olifera in sample bottles and the bottles stoppered. Tosterilize the immediate air, flaming was used at the mouth of the sample bottles to avoidpossible sample contamination by bacteria in the air around the sampling locations Samples were collected from these streams in the study area since they were found to be the commonly usedwater sources by locals. The sampling sites were identified to represent even distribution of unprotected streams across the study area. Random sampling was used in the study.Samples collected were labeled and placed in a cooler box containing ice blocks and then transported within six hours to Eldoret Water.

4.2 Preparation Of Moringa Oleifera Seed

Extract Fully matured Moringa oleifera seeds were collected from Marigat forest. The seeds were air-dried in direct sun for a week. The shells surrounding the seed kernels were removedusing a knife and the kernels were pounded using laboratory mortar and pestle into fine powder. The powder was sieved using a strainer with a pore size of 2.0 mm to separate the coarse powder and obtain only the fine powder to achieve solubilization of active ingredients in the seed.

Fig.(A) Moringa Oleifera Seeds

Fig.(B) Moringa Oleifera Seed Powder

This powder was used to prepare M. oleifera stock solution for water purification. The stock solution was prepared by mixing 10, 20, 30, 40, 50 and 60 g of fine seed powder in 1000 ml of distilled water and solution later filtered. The suspension was vigorously shaken for 30 min using a stirrer to promote water extraction of the coagulant proteins and this was then passed through filter paper. The filtrate was used within an hour

4.3 Designing An Improvised Charcoal

Water Filter Fresh wattle tree charcoal was used as it was readily available and has no known side effects. Crushed charcoal was graded from 0.5 mm to 5mm using standard sieves. The graded charcoal sample was sterilized by boiling in water for 15 minutes before use in the filter. A 2-litre cylindrical plastic container with the lower part cut open was obtained. The smaller opening was covered with a piece of fabric that acted to prevent the charcoal from falling out or running through with the water. Approximately 500 g of crushed charcoal of varying sizes was packed into the container tightly. This was meant to create as fine a matrix as possible for the water to drip through slowly, th us trapping more sediment. The crushed charcoal was filled up to about halfway the cylinder. The filter was placed atop a sterile container to collect the filtered water.

Fig.(C) Activated Charcoal

4.4 Sample Filtration

A 500 ml sample of raw water was slowly poured into the filter and allowed to slowly percolate through. The filtrate was collected in a fine aggregate, course aggregate, activated charcoal, and moringa oleifera seeds powder etc . The raw and the filtered samples were later analysed for total coliforms, fecal coliforms and biological oxygen demand.To determine the effectiveness of combined activity of M. oleifera and charcoal filter, stream water was initially treated with optimum stock solution i.e. 40 g of M. oleifera seed powder in 1000 ml of distilled water. The treated sample was then passed through the charcoal filter in a similar procedure of filtration undertaken.

Fig. (D) Filter Media

5.Applications

- Graywater includes water from showers, bathtubs, sinks, kitchen, dishwashers, laundry tubs, and washing machines.
- The major ingredients of gray water are soap, shampoo, grease, toothpaste, food residuals, cooking oils, detergents, hair etc. In terms of volume, gray water is the largest constituent of total wastewater flow from households.
- In a typical household, 50-80% of wastewater is gray water, out of which laundry washing accounts for as much as 30% of the average household water use.
- The key difference between gray water and sewage (or black water) is the organic loading. Sewage has a much larger organic loading compared to gray water.
- In applications which do not need drinking water quality such as industrial, irrigation, toilet flushing and laundry washing. This will, in turn, reduce freshwater consumption, apart from wastewater generation.
- Community benefit in reducing demands on public water supply.

6.Re-use

- There are two main systems for greywater recycling – centralized or decentralized. In a decentralized system, greywater collected from one or more apartments is treated inside the house.
- Greywater reuse treatment systems can be simple, low-cost devices or complex, expensive wastewater treatment systems. An example of a simple system is to route greywater directly to applications such as toilet flushing and garden irrigation.
- Water-efficient plumbing fixtures are vital when designing a household greywater reuse system. Some examples are low-flow shower heads, faucet flow restrictors, and low-flow toilets.
- Garden irrigation is the predominant reuse method for situations where greywater can be bucketed or diverted to the garden for immediate use.
- Greywater systems are relatively easier to install in new building constructions as house or offices already constructed on concrete slabs or crawlspaces are difficult to retrofit.
- Protection of public health is of paramount importance while devising any greywater reuse program. Although health risks of greywater reuse have proven to be negligible, yet greywater may contain pathogens which may cause diseases.

7. Discussion

•Effects of moringa oleifera and charcoal filter on microbiological parameters.

Moringa oleifera reduced the total coliforms by approximately 33%fillteration over charcoal by a further 33%.A combination of M oleifera and charcoal filteration reduced the total coliforms population by 92% .This Reduction was significantly different from either using charcoal of M . Oleifera singly processing the water by coagulation using M .Oleifera as natural coagulant showed that the treatment with M . Oleifera provided additional of reduced total coliforms. Moringa oleifera seeds can be applied to treat water on two levels. Acting both as a coagulant and a anti- Microbial agent . It is generally accepted that moringa plant works as a coagulant that leads to the formation Of flocs that settle at the bottom of water. The antimicrobial aspects as a moringa plant continue to be investigated While their are ongoing research work being conduct on the natural and characteristics of these components .It is accepted that treatment with moringa solutions remove 90-99% of the impurities in water.

Table 3.1.6 (1) Water Qualities Standard In India (Source IS 2296 : 1992)

Sr. No	Parameters	Gray Water	Affort Treated By Filter Media Grey Water	Standard IS River Water (Gangotri)
1	Ph	9.8	5.83	7.2
2	BOD	130 mg	20 mg/l	4.5
3	COD	122.2 mg	65 mg/l	25.0
4	SO_4	3 mg	0.05 mg/l	32.0
5	Hardness	455	12.7	114

Table 3.1.6(2) : Before The Treatment For Domestic Gray Water

Parameter	Value
pH	9.8
TDS	23.2gm/L
TSS	3.52gm/L
BOD5	130mg/L
Alkalinity	1225mgCaCo3/L
Turbidity	12NTU
Sulphate	3mg/L

8.Result

.Based on the objectives of the study of findings of the study were as follows

8.1 Efects of moringa oleifera and charcoal filter on assessment of Microbiological parameters.

In this study the microbiological parameters under investigatation were total coliforms fecal coliforms and Biological oxygen demand

2 Total coliforms

The results of total coliforms in the sample water there were significant difference in total coliforms count (P<0.05) among the different treatment of the sample water in the area of study

3 Fecal coliforms

The results of fecal coliforms shows that there were significant difference in fecal coliforms count

(P< 0.05) among the different treatment moringa oleifera reduced the population of 21% charcoal

Filtration further reduced the population by significant 82%

4 biological oxygen demand (BOD)

The BOD levels were found to be significantally different (p<0.05) among the different treatment

BOD reduction by moringa oleifera was 20%

9.Conclusion

Based on this study,the following conclusions were mode

1) moringa oleifera seed powder demonstrated the presence of coagulation properties in water treatment

2) There was enhanced improvement in water quantity when Moringa oleifera seed extracts were used in combination With charcoal filter against the test microorganism

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