Improvement of Water Quality in Flooded Area Using Plant-based Materials

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Abstract— The aim of this research was to assess the water quality of flooded area and to set up the modified household water treatment system. In this study, the contaminated water samples were collected from flooded area in Yanbye Township (latitude 19° 05′N and longitude 93°52′E), Rakhine State, Myanmar and assessed the pollution level via physicochemical parameters and total bacteria count. Overall values of study area indicated that some minerals such as lead, iron and cadmium were found in high pollution level. Moreover, high mean count of total coliforms was also found in one of the water samples. The conventional treatment design for contaminated water from flooded area was modified by coagulation-filtration-disinfection approach. In the lab scale study, experiments with varying reaction parameters such as type of coagulant (*Tamarindus indica*, and *Moringa oleifera* seed kernels and alum), coagulant dose (5 - 25 mg/L) and coagulation time (30 -120 min) were conducted to study their effects on the coagulation process. In the filtration system, a dual-media consisting of sand and activated charcoal yielded good results in reducing contaminants from water. A full-scale household water treatment unit was also constructed. The system consists of 200 L capacity tank each for sedimentation and coagulation, and three filtration columns which were serially packed with gravel (4 to 5 mesh), sand (20 mesh), and activated coconut shell charcoal (8 mesh). This cost effective and modified household water treatment system has shown a significant removal of heavy metals, TDS, turbidity and total coliform bacteria.

Index Terms— Minimum 7 keywords are mandatory, Keywords should closely reflect the topic and should optimally characterize the paper. Use about four key words or phrases in alphabetical order, separated by commas.

1 Introduction

SAFE and readily available water is important for public health, whether it is used for drinking, domestic use and food production purposes. According to the World Health Organization, 2.6 billion people have gained access to an improved drinking- displaced roughly half a water source since 1990. 663 million people rely on unimproved sources, including 159 million dependent on surface water [1]. In Myanmar, through June, July and August 2016, heavy monsoon flooding temporarily displaced half a million people in 11 states and regions. The flooding also damaged agricultural land, fish farms, schools, roads, bridges, wells and communal buildings, consequently, thousands of people lack access to clean water for bathing, washing and drinking [2].

Ponds and wells have been contaminated by floodwaters, including seawater in coastal Rakhine state, Myanmar as well as faeces from farm animals that have sought safety on embankments around ponds. The production of drinking water from most contaminated water sources involves coagulant use at a coagulation/flocculation stage to remove contaminants in the form of suspended and colloidal material. Coagulation process is easy, economical and ecofriendly which is being widely used for rural area all over the world. Many water purification tablets; inorganic coagulants and synthetic organic polymers and alum are widely used in urgent water treatment processes. Aluminium salts are cheap and are the most widely used coagulants in water and wastewater treatment all over the world. Regarding the application of synthetic polymers, the presence of residual monomers is undesirable because of their neurotoxicity and strong carcinogenic properties.

In recent years there has been considerable interest in the development of usage of natural coagulants which can be produced or extracted from microorganisms, animal or plant tissues. These coagulants produce readily biodegradable and less voluminous sludge. The use of natural materials of plant origin to clarify turbid raw waters is not a new idea. Natural coagulants have been used for domestic household for centuries in traditional water treatment in tropical rural areas [3].

Natural seed extract on the turbidity removal of surface water by using *Tamarindus indica* was also reported [4]. *Tamarindus indica* is a leguminous tree in the family of Fabaceae indigenous to tropical Africa. The genus *Tamarindus* is a monotypic taxon, having only a single species. It is used as traditional medicine in India, Africa, Pakistan, Bangladesh, Nigeria, Myanmar and most of the tropical countries [5].

Moringa oleifera seeds are also used as a primary coagulant in drinking water clarification and wastewater treatment due to the presence of a water-soluble cationic coagulant protein able to reduce turbidity of the water. Seeds are powdered and added to the water straight or after preparing crude extract [6]. *Moringa oleifera* is the most widely cultivated species of 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 is being grown in West, East and South Africa, tropical Asia, Latin America, the Caribbean, Florida and the Pacific Islands [7]. Almost every part of the plant (leaves, flowers, seeds, roots and bark) can be used as food or with medicinal and therapeutic purposes [8], especially in developing countries.

Most particulate matter cannot settle by gravity and their sizes are so small that they pass through the pores of most common filtration media. Granular charcoal can be used during filtration as a filter media. It can be quite effective at removing some tastes, odours and colour. Health can be compromised when harmful bacteria, viruses, parasites, pesticide residue and heavy metals contaminate drinking water either at the source, through seepage of contaminated runoff water,

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or within the piped distribution system. Moreover, unhygienic handling of water during transport or within the home can contaminate previously safe water. For these reasons, many of those who have access to improve water supplies through piped connections, protected wells or other improved sources are, in fact, exposed to contaminated water [9].

Therefore, potentially billions of people can benefit from effective household water treatment and safe storage. In this study, the pollution level of flooded water was assessed and the treatment system of contaminated water was optimized by coagulation-filtration-disinfection approach using naturally available materials. Based on the optimum results, the household water treatment unit will be applied practically in rural area.

2 MATERIALS AND METHODS

2.1 Sample Collection

The surface water samples were collected from post-flooded area of Padin Su ward, Ramvee (Yanbye) Township (latitude 19° 05′N and longitude 93°52′E) in Rakhine State (Figure 1). A collection of the samples was made in wet season (October, 2016). The water samples were taken at a depth of 0.3 m below the surface of water with 1 L of sterilized, prewashed polyethylene containers. The sample was stored in the laboratory and maintained at room temperature.

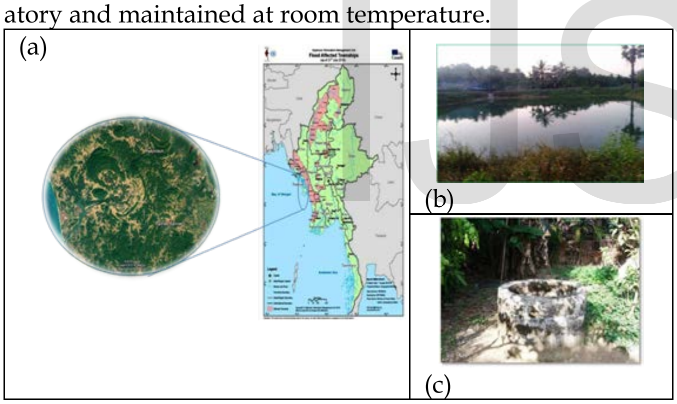

Figure 1 Sample collection sites (a) map of Ramvee (Yanbye) Township, Rakhine State, Myanmar (b) pond (sample I) and (c) well (sample II), Padin Su Ward, Ramvee

2 Determination of Some Physicochemical Parameters of Water Sample

The analysis of the quality parameters was carried out according to the reported methods [10]. The concentrations of lead, iron, copper and cadmium ions were determined by atomic absorption spectrophotometer at Universities' Research Center (URC), University of Yangon. Nitrate, ammonium and phosphate concentrations were determined by UV-visible spectrophotometric method using a Carry 50 spectrophotometer. The DO and pH measurement were carried out on a DO and pH meter. The COD was found out by $KMnO_4$ titration. The turbidity of the water samples was determined using a Hanna LP 2000 turbidimeter. The total dissolved solid was determined weighing the residue resulted after water evaporation and drying at 105°C; a Denver analytical balance has been used. Total hardness and total alkalinity were revealed by the EDTA and acid-base titrimetric method. The total coliform and *E. coli* bacteria in water samples were determined by the multiple tube method.

2.3 Collection of Coagulating Materials

Coagulating materials used in this study are chemical coagulant (alum) and plant-based natural coagulants (*Tamarindus indica* and *Moringa oleifera* seed kernels). The chemical coagulant aluminum sulphate (alum) was purchased from local chemical shop and was stored in air-tight plastic container until used. *Tamarindus indica* (Tamarind) (Figure 2-a) seed was collected from Sittway Township, Rakhine State and *Moringa oleifera* (Figure 2-b) seed was collected from Nyaung U Township, Mandalay Region. *T. indica* seeds were dried in sunlight, detached the seed shell and grounded to fine powder using a mortar. *M. oleifera* seeds were harvested when they were fully matured. This is determined by observing if there are any cracked pods on the plants. The pods were plucked and cracked to obtain the seeds which were air dried at room temperature for two days. The shells surrounding the seed kernels were removed using a knife and the kernels were ground using blender into powder form and sieved to obtain fine particles.

2.4 Optimization the Coagulating Parameters

The coagulation parameters to be studied were different coagulant doses and coagulation times. In order to determine coagulation efficiency, the experiment was completely arranged in three different series (alum,*T. indica* and *M. oleifera*). Each series consists of five different concentrations of the solutions for the loading dose prepared by adding 5, 10, 15, 20 and 25 mg of various coagulants into beakers containing 1L of water. The mixtures in the beakers were rapidly stirred for 5 min followed by 20 min slow stirring using stirrers. The suspensions were left to stand without disturbance at various time 30, 45, 60, 90 and 120 min and the supernatants formed were decanted and subjected to determine the turbidity, total dissolved solids, COD, pH and bacteria count.

Figure 2 Fruits and seeds of (a) Tamarindus indica (b) Moringa oleifera Lam.

2.5 Preparation of Filtration Materials

The sand was collected from point beach, Sittway Township, Rakhine State. It was purified step by step washing with water and then dilute acid to obtain pure sand and dried at room temperature followed by meshing. Coconut shells were pyrolysed in a furnace at 600oC for 2 h. The pyrolysed shells were pulverized and sieved to obtain 8 mesh sizes. The pulverized coconut shell charcoal was washed with water and dilute acid to remove impurity such as adherent powder. The obtained charcoal particles were dried overnight in an oven at 110oC and cooled to room temperature, and stored in an air tight container.

2.6 Optimization the Filtration Parameters and Loading Capacities

A column (1.2 × 24 cm dimension) with a tap attached was clamped on a stand so that it was perfectly vertical. The supernatants formed from coagulation process were added into the filtration unit containing filter media using two layers of activated coconut shell charcoal and sand with supporting media (gravel). After filtration process, the outlet water was subjected for the removal percent of contaminants such as turbidity, total dissolved solids and COD via optimization of the effect of filtration rate (25, 16.6, 10, 8.3, and 7 ml min-1), filtration volume (50, 60, 70, 80, 90 mL), filter media height (thickness of the filter bed) using gravel (4 cm), sand (4 cm) and different height of coconut shell charcoal (2, 2.5, 3, 3.5, and 4 cm), and number of cycle of filtration run (1, 2, 3, 4 and 5 times). The water sample was added from the top of the column. The tap was opened and filtrate was collected and determined the amount of contaminants. Based on the optimum parameters, the loading capacity of filter unit was calculated.

2.7 Construction of Household Water Treatment Unit in the Field Study

According to the initial experiences from the lab-scale system, a full-scale system of a household water treatment unit was constructed. The system consists of 200 L capacity tank each for sedimentation and coagulation, and (6.4 cm dia. x 91.4 cm length) of three filtration columns packed with 53.3 cm thick of activated coconut shell charcoal (8 mesh), 15.24 cm thick of sand (20 mesh), and 15.24 cm thick of gravel (5 mesh) (Figure 4). Treated water naturally flowed from the outlet. The time taken for the 200 L of water was 7 h, and the amount of treated water was 180 L. The percent reduction of contaminants after household water treatment process was determined.

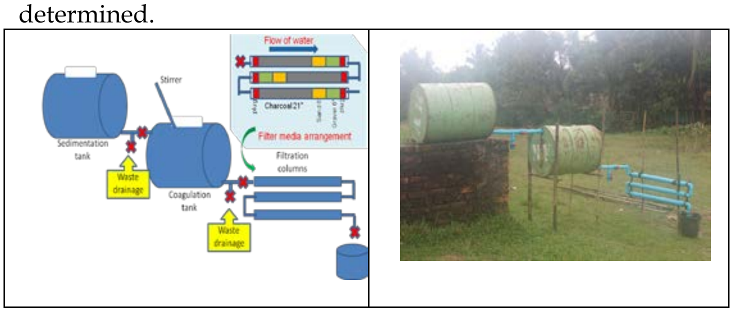

Figure 3 Block diagram and full- scale system of household water treatment unit

3 RESULTS AND DISCUSSION

3.1 Physicochemical Parameters of Water Sample

pH is an important variable in water quality assessment as it influences in many biological and chemical process within a water body. The pH of given samples (pond water-SI and dug-well water-SII) was found 6.6 and 6.5. The pH of most natural water is found between 6.5 and 8.5 (WHO standard), so the given samples from studied area were assumed that natural water. The measurement of DO can be done to indicate the degree of pollution by organic matter, the destruction of organic substances and the level of self purification of the water. Range of 4-5 mg/L of DO is the minimum amount that will support fish population. The DO level of given water samples was found 6.4 for S I and 1.5 for S II and supposed to be not appropriate for aquatic life. The COD of water samples were found as 5.52 and 3.05 mg/L for SI and SII and below maximum permissible level of WHO standard (10 mg/L). In this study, BOD values were found very low in the range of 3.5 to 0.5 mg/L in sampling sites SI and SII.

Many dissolved substances are undesirable in water. Dissolved minerals, gases and organic constituents may produce aesthetically displeasing colour, tastes and odour. The observed TDS value was low (85 and 30.1 mg/L for SI and S II) under the literature value of 500 mg/L. Total hardness of water sample was found to be 333.4 and 181.5 mg/L for SI and SII. Thus the water in the sampling site was found to have total hardness value below the WHO standard of 500 mg/L. The turbidity values were found in 2.6 NTU for SI and 2.2 NTU for SII. The types and concentration of suspended matter controls the turbidity and transparency of the water. Suspended matter consists of silt, clay, fine particles of organic and inorganic matter, soluble compounds, plankton and other microorganisms. According to the literature guideline values (4 NTU), the water sample was suitable for drinking purpose. The main sources of alkalinity are rocks, which contains carbonates, bicarbonates and hydroxide compounds. Borates, silicates, and phosphates may also contributes to alkalinity. In the present study, the total alkalinity of the sample was found 290.2 and 150.3 mg/L for SI and SII and the water sample was found to be under the permissible level of WHO standard (500 mg/L). The levels of ammonia nitrogen in drinking water should not exceed 0.5 mg/L. The ammonia contents of the samples did not exceed 0.05 mg/L, so that it was not lethal. The nitrate nitrogen concentration of water samples were found about 0.01 mg/L (Table 1) even though the WHO guideline for drinking water was 1.0 mg/L. This implies that all the samples were suitable for drinking water purposes. The phosphate concentrations in the water samples were found in the range of 0.2 and 1.04 mg/L indicating the requirement of additional treatment facilities. The high phosphate contents may be due to the phosphate fertilizers used in the vegetable sites in the village.

3.2 Trace Elements of Water Samples

The contents of lead in both collected water samples were found 0.4 to 0.1 mg/L (Table 2). These observed values are higher than the standards of WHO. Cadmium content in pond water sample was found as 0.06 mg/L and it is higher than WHO standard (0.003 mg/L) but it was not detectable in the dug-well water.

Table 1 Physicochemical Characteristics of Water Sample

Parameter	Unit	S I	S II	WHO std.*
pH	-	6.6	6.5	6.5-8.5
Temperature	oC	26.5	25.5	-
Turbidity	NTU	2.6	2.2	4
TDS	mg/L	85.0	30.1	500
NH3_N	mg/L	0.05	0.03	0.5
Hardness	mg/L	333.4	181.5	500
NO3_N	mg/L	0.01	0.01	1.0
PO4 3-	mg/L	0.2	1.04	0.02
Alkalinity	mg/L	290.2	150.3	500
COD	mg/L	5.5	3.05	10
DO	mg/L	6.4	1.5	-
BOD	mg/L	3.5	0.5	6

* World Health Organization standard for drinking water, 2011

Table 2 Some Elements in Water Samples

Parameters	Unit	S I	S II	WHO std.*
Lead	mg/L	0.4	0.10	0.01
Iron	mg/L	1.2	0.09	0.3
Cadmium	mg/L	0.06	ND	0.003
Copper	mg/L	0.07	ND	2.0

* World Health Organization standard for drinking water, 2011

ND = Not detectable

The iron content in pond water sample (1.2 mg/L) was higher than the WHO standard of 0.3 mg/L but found as low content in dug-well water (0.09 mg/L). Iron distribution is heavily regulated in mammals, partly because iron has a high potential for biological toxicity. Large amount of ingested iron can cause excessive levels of iron in the blood. High blood levels of free ferrous ion react with peroxides to produce free radicals which are highly reactive and can damage DNA, proteins, lipids and other cellular components. Copper was found as 0.07 mg/L in pond water sample but not detectable in dug-well water sample (Table 2). WHO standard for copper in drinking water is 2.0 mg/L. The minimum contaminated level for copper is based on the expectation that a lifetime of consuming copper in water at this level is without adverse effect [11].

3.3 Total Coliform in Water Sample by Multiple Tube Method

The total coliforms contents in water samples from S I was observed >110 MPN/100 mL, but S II (dug-well water) contained only 7 MPN/100 mL (Table 3). It was observed that E. coli was not detectable in the collected water samples. According to these results, the water is harmful for drinking and domestic purposes. The water should be treated with appropriate techniques before use.

Table 3 Microbiological Parameters

Parameters	Unit	S I	S II
Total coliform	MPN/100mL	>100	7
E. coli	MPN/100mL	ND	ND

ND= not detectable

3.4 Removal of Contaminants from Water Samples using Different Coagulants

As shown in Figure 4 (a), it was observed that the turbidity was removed in the range between 78.9 to 90.3 % by alum, 75.9 to 82.0 % by *T. indica*, and 80.3 to 90.3% by *M. oleifera* coagulants. According to the results, the effective dose in the removal of turbidity was found to be 15 mg/L for two types of coagulants: alum and *T. indica*, however, the effective dose of *M. oleifera* coagulant was found to be 20 mg/L.

Turbidity may be caused when light is blocked by large amounts of silt, microorganisms, plant fibers, saw dust, wood ashes, chemicals and cool dust. Any substance that makes water clouding will cause turbidity. It is clearly seen that the concentration of *M. oleifera* powder of 20 mg/L loading dose and 15 mg/L of *T. indica* seed powder as coagulants gives similar effect on turbidity compared with alum of loading dose of 15mg/L. This shows that *T. indica* and *M. oleifera* can be adopted to be used in water purification. This is likely to lead to cost reduction in the conventional water treatment than those of using alum and no threat to human life in case of overdose as stated in the reported findings [12]. The method of allowing water to settle without any coagulant is not efficient as proven by the treatment results. The quality of water for consumption for rural communicative in Myanmar can be improved by first adding *T. indica* and *M. oleifera* powder before using the turbid water.

The TDS was found to be reduced in the range between 75.0 to 77.7 % by alum, 1.4 to 6.0 % by *T. indica*, and 73.5 to 80.3 % by *M. oleifera* coagulants, respectively (Figure 5-b). According to the results, the effective dose in the removal of TDS was found to be 15 mg/L for two types of coagulants; alum and *T. indica*, and the effective dose of *M. oleifera* coagulant was found to be 20 mg/L. The TDS was found to be reduced similarly by alum and Moringa coagulants, respectively. However, very little significant effect of *T. indica* was found on TDS removal from water sample. Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates) and some small amounts of organic matter that are

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dissolved in water. These soluble matters probably couldn't be discharged by the natural polysaccharide in *T. indica* seed kernel or disturbed by other polymers including it. *T. indica* seed kernel contains polysaccharides and fat, tannins, protein and amino acid in small portion. WHO guideline for TDS is 500 mg/L. High level of TDS in drinking water may be objectionable to consumers. TDS concentrations less than 500 mg/L should ensure safety from almost all inorganic constituents. Above 500 mg/L, the individual constituents contributing to TDS should be identified, quantified, and evaluated.

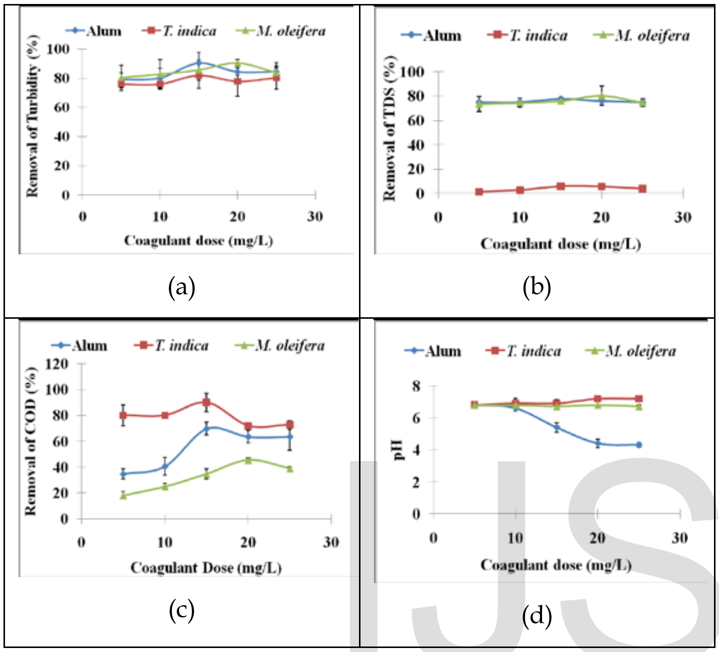

Figure 4 Effect of different coagulant doses on the removal of (a) turbidity (b) total dissolved solids (c) COD and (d) changes of pH from sample water

In environmental chemistry, the content of COD indicates the amount of organic pollutants found in the water, making COD a useful measure of water quality. In this research, the COD contents in water samples were reduced by using various doses of coagulants. The COD was found to be removed in the range between 34.8 to 69.8 % by alum, 72.0 to 90.0 % by T. indica, and 18.2 to 45.4 % by M. oleifera coagulants, respectively (Figure 4-c). According to the results, the effective dose in the removal of COD was found 15 mg/L for two types of coagulants: alum and *T. indica*, and the effective dose of *M. oleifera* coagulant was found to be 20 mg/L.

The COD was found to be removed higher by *T. indica* and lower by *M. oleifera* seed kernel. Higher COD levels mean a greater amount of oxidizable organic material. To reduce COD, some oxidizing agent should be used with or without catalyst. The type of oxidation needed depends to the types of COD. There are several types of COD: one type contains sulphide, thiosulphide, sulphite, the other one is phenols, cyanide, amines and the next one TOC and paraffins. The chemical oxygen demand (COD) test is commonly used to indirectly measure the amount of organic compounds in water. The results means the oxidizing agents contain in the *T. indica* seed kernels is appropriate the type of COD in the water sample.

All the coagulant treatments at varying loading doses affected on the pH of water level (Figure 4-d). In the alum used coagulation, pH of water sample was found to decrease from 6.8 to 4.2 which fall within the solutions were becoming more acidic. This was attributed to the fact that the alum in the treatment process produced sulphuric acid which lower the pH levels. The increase in acidity could be due to the trivalent cation aluminium which serves a Lewis acid, since it can accept a lone pair of electrons. *T. indica* as a coagulant lies in the presence of water soluble cationic proteins in the seeds. T. indica coagulant was found to be a dose dependent coagulant. The pH increases with increasing concentration of the *T. indica* coagulant. This suggests that the basic amino acid present in the protein of *T. indica* would accept a proton from water resulting in the release of a hydroxyl group making the solution to be slightly basic.

However the contrast was observed with the *M. oleifera* treatment. It could not change the pH of water sample during coagulation treatment up to 20 mg/L concentration. The action of *M. oleifera* as a coagulant lies in the presence of water soluble cationic proteins in the seeds. Although, there is a slight shift in the pH value, it did not modify the chemistry of the water where the water remains in neutral state. This is because M. oleifera is a natural coagulant that did not release any chemicals in the water and it only react in the physical way where the polyelectrolyte present in the kernels attract the turbid and microorganisms. The seeds kernels of *M. oleifera* contain lower molecular weight water soluble proteins which carry a positive charge when the seeds are crushed and added to water, the protein produces positive charges acting like magnets and attracting predominately negatively charged particles such as clay, silk and other toxic particles [13]. Under proper agitation, these bound particles then grow in size to form the flocculates which are left to settle by gravity. This accounted for the effectiveness of *M. oleifera* as a coagulant for raw water purification.

To determine the effect of coagulation time on removal of contaminants from water sample, the optimum coagulant doses of 15 mg/L each for alum, *T. indica*, and 20 mg/L for *M. oleifera* seed were used for theremoval of contaminants ((Figure 5). The coagulation times were varied at 30, 45, 60, 90, and 120 min. According to the experimental results, optimum coagulation time was 120 min. The maximum % reduction of turbidity was found to be 88.2, 80.4 and 89.4 % by alum, *T. indica*, and *M. oleifera* coagulants, respectively. The maximum percentage reduction of total dissolved solids was 78.2 % for alum, 5.9 % for *T. indica*, and 77.6% for *M. oleifera* coagulants. The COD values decrease at 120 min with the removal percentage of 69.7 % for alum, 86.8% for *T. indica*, and 50.3% for *M. oleifera* coagulants.

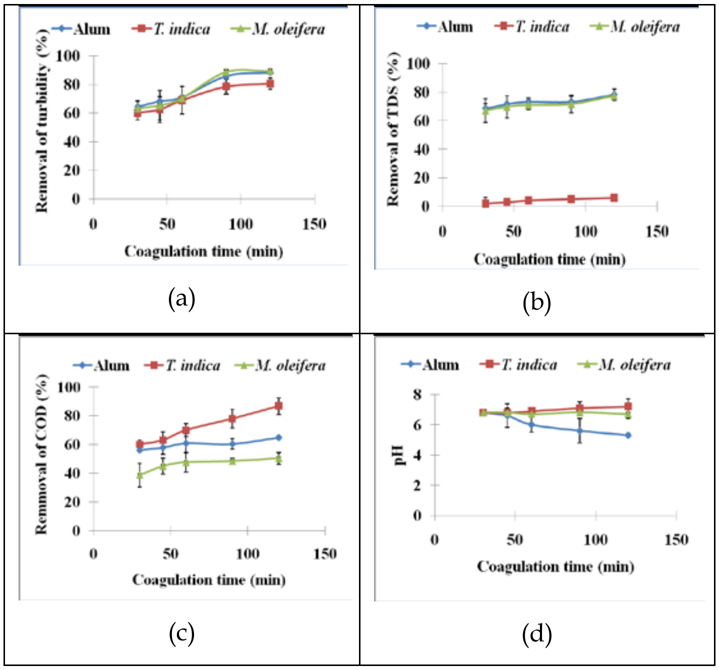

Figure 5 Effect of different coagulant time on the removal of (a) turbidity (b) total dissolved solids (c) COD and (d) changes of pH from sample water

T. indica coagulant could not remove the bacteria but *M. oleifera* coagulant possesses the ability to remove bacteria from water by the results indicated a reduction in the bacteria count (Figure 6). The demonstration of the ability of a recombinant *M. oleifera* protein to decrease the viability of gram-negative or gram-positive bacteria cells and to mediate the aggregation of negatively charged particles in suspension, such as bacterial cells, clay or silicate microspheres.

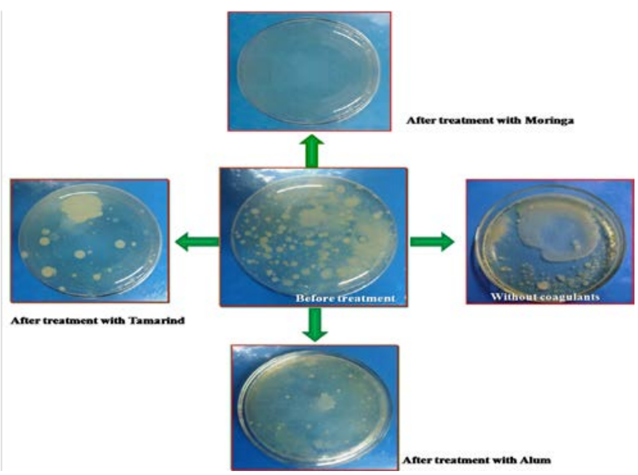

Figure 6 Screening of bacteria in water samples before and after treatment with alum, Tamarind, and Moringa coagulants

3.5 Removal of Contaminants from Water Samples by Column Filtration

Figure 7(a) indicated relationship between removal percent turbidity, total dissolved solids, COD and rate of filter run. In this study, the flow rates were maintained within the range of 25 to 7 mL min-1. By decreasing the flow rate, the removal of contaminants was found to be better and the residual contaminants at the flow rate of 7 mL min^{-1} showed 74.0 % of turbidity, 96.0 % of total dissolved solids and 88.1 % of COD. Therefore, the optimum flow rate should be 7 mL min^{-1} while the higher flow rate will result the decrease in efficiency of media. Figure 8(b) mentioned the changes of residual contaminants of water at different filter media (coconut shell charcoal) heights 2, 2.5, 3, 3.5 and 4 cm. According to these results, if the height of filter media is short, the filtration efficiency is not good. In accordance with the results from 1st – 5th cycles of filter run, first time of filtration cycle was observed the removal of 87.0 % for turbidity, 83.2 % for total dissolved solids and 84.0 % for COD (Figure 8-c). It was the best effective removal of contaminants from wastewater. However, the 5th times of filtration cycle, removal percent did not change in compare with 4th cycle. At this cycle, filter performance was terminated. Figure 7 (d) shows the changes of turbidity, TDS and COD residue of model turbid water at different volumes of filter rum. The 50, 60, 70, 80, 90 mL of water volumes were used.

It was observed that, small volume of water sample shows higher reduction of contaminants. The relative important of waste removal mechanisms will depend largely on the nature of the water being treated, choice of filtration system, degree of pretreatment and filter characteristics.

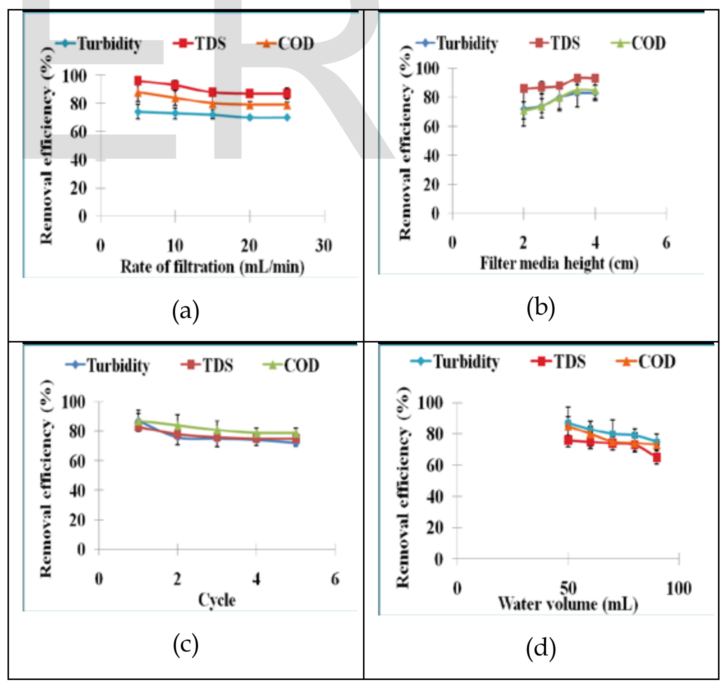

Figure 7Effect of (a) rate of filtration (b) filter media height (c) cycle of filter run (d) and water volume on the removal of turbidity, total dissolved solids and COD from water sample

3.6 Performance of Household Water Treatment Installation

Household water treatment has emerged as a viable solution for small and large population, especially in rural areas concerning with the waterborne diseases. Based on the initial experiences from the experimental system, a full-scale installation of a household water treatment unit was constructed. Quality of treated water ranged within allowable limit of international standards. Due to the lack of proper water treatment system in the rural communities, the best cost effective option is to use coagulation process. But the chemical coagulants such as alum-based coagulant can cause the development of Alzheimer´s disease and similar health related problems in human beings.

Table 4 Pollution Level Removal of Treated Water from the Household Unit

Treatment Process	% Removal				Bacteria count * (MPN/100 mL)
	Heavy Metals		TDS	Turbidity	
	Cu	Cd			
Coagulation	87	90	73	74	6
Filtration	97	98	95	92	<2

*Initial bacteria count : >110 MPN/100 mL

It is therefore desirable to replace these chemical coagulants with plant-based coagulants to counteract the aforementioned drawbacks. M. oleifera is a tropical multipurpose tree that is commonly known as the miracle tree. Among many other properties, M. oleifera seeds contain a coagulant protein that can be used either in drinking water clarification or wastewater treatment. It is said to be one of the most effective natural coagulants and the investigation on these kinds of water treatment agents is growing nowadays. M. oleifera seed has also been found to have antibacterial activity (Madsen et al., 1987). In this research, the M. oleferia seed was used as the natural coagulant and coconut shell charcoal and sand were used as filter media. The gravel was used as the supporting material. In the coagulation step, the contaminated copper was removed by 87 % and cadmium was 90 %. The percent reduction of total dissolved solids and turbidity were 73 and 74 %, respectively. After the filtration, the heavy metals present in the water sample were removed up to 97 and 98 % for copper and cadmium, respectively. The total dissolved solids and turbidity of water sample were reduced by the percentage of 95 and 92 %, respectively.

4 Conclusion

In this research, study on the quality of contaminated water from flooded area was assessed and followed by optimizing the conventional water treatment system and constructing the household water treatment unit in rural area. The water samples were collected from the post-flooded area, Yanbye Township, Rakhine State. The finding inferred that the water samples from studied area were harmful for drinking and domestic purposes. The water should be treated with appropriate techniques before use. According to the results of optimization the conventional treatment, the seed kernel coagulant from Moringa oleifera was found to be used for simultaneous coagulation and disinfection in water treatment. The loading capacity was evaluated as 6.19 mLmin-1cm-2 in accordance the results of laboratory scale experiment. Based on the optimum conditions, a full-scale system of a household water treatment unit was also constructed. Moreover, this treatment design could be significantly received increasing interest by people who live in this area.

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