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RESEARCH ARTICLE

PERFORMANCE COMPARISON BETWEEN MORINGA OLEIFERA AND ALUM IN WATER AND WASTEWATER TREATMENT: A NON-SYNERGIC APPROACH

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ABSTRACT

In order to ensure safe and adequate water availability, many communities have engaged in water and wastewater treatment. Some of chemicals used for water treatment are less effective due to high costs and side effects making use of natural coagulants an ideal option. This study was conducted to compare effectiveness of Moringa Oleifera (MO) seeds powder as a natural coagulant with Aluminium sulfate (Alum) as a chemical coagulant. The effectiveness and efficiency of MO against Alum was established by using jar test method before and after groundwater treatment. By using concentrations of MO and Alum ranging between 50 to 200 mg/L, a significant reduction of pH, EC, TDS, turbidity, total hardness, chloride content, total alkalinity and total coliforms was observed while beyond it efficiency was impaired. MO treated samples showed promising quality than Alum solution that significantly lowered the pH of water. The established optimal MO seed powder dose for turbidity treatment was 200 mg/L.

INTRODUCTION

Transmission of most diseases in developing countries is through intake of contaminated water leaving behind serious health and economic effects. Eman *et al.* (2010) reported that, about 1.6 million people from developing countries are using contaminated water and more than 6 million children die from diarrhoea every year. Water treatment is presumed being a solution nevertheless it faces challenges including high costs, seasonal variation of raw water quality and immediate availability of chemical coagulants (Okuda *et al.,* 2001). Furthermore chemical coagulant like $Al_2(SO_4)_3$ and $FeCl_2$ used in municipal drinking water treatments being causative agent of neurological diseases such as pre-senile dementia (Patrick *et al.,* 2004). To overcome these challenges, Mataka *et al.,* (2006) and Broin *et al.* (2002) recommended the use of natural coagulants for water treatment. Kihampa (2011) discovered existence of natural coagulants extracted from microorganisms, animals and plants which were safe for human health. Yongabi *et al.* (2010), Eman *et al.* (2010) and Nicolas *et al.* (2005) reported MO seeds powder being excellent natural coagulant for water treatment due to the presence of positively charged water-soluble proteins. These proteins bind with negatively charged particles like silt, clay, bacteria and toxins allowing 90-99.9% settle at the bottom thus easily removed by filtration (Arnoldsson *et al.,* 2008). Similarly, Akhtar *et al.* (2006) reported MO seeds being effective sorbents for removal of heavy metal and volatile organic compounds in the aqueous system.

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MATERIALS AND METHODS

Enough groundwater samples about 12 liters were collected in half-filled sterilized bottles for bacteriological analysis from Ng'hong'onha village bordering with the University of Dodoma. The village was selected since this community relies on low quality untreated groundwater while there are plenty MO plants. Another 12 liters were collected in polyethylene bottles for physico-chemical parameters analysis. MO seeds collected from the same village were completely dried, shelled then crushed to a fine sieved powder in order to be effective as Ndabigengesere *et al.* (1995) similarly did it. From a sieved powder, a stock solution was then prepared by mixing MO fine powder with distilled water. Water analysis was done before and after treatment of samples with prepared MO and Alum solutions of 50, 100, 150, 200 and 250 mg/L. Asrafuzzaman, (2011) used MO dosage of 50, 60, 70, 80, 90 and 100 mg/L while Dalen *et al.* (2009) used Alum and MO in a synergic approach. The alum used as a chemical coagulant were obtained from DUWASA.

RESULTS

pH Variation of Water Samples

The pH value of raw water before treatment was pH 7.46, after treatment with MO as per Chart 1 pH decreased to a minimum value of 6.12 at 150 mg/L then increased to 7.12 at 250 mg/L. During treatment with Alum the pH decreased from 7.46 to 5.37 with respect to the dosage increase.

Electrical Conductivity and TDS Measurements

Electrical conductivity indicated in Chart 2 rapidly decreased from 1139 to 287.2 then increased to 356.1 µS/cm as the MO dose increased from 50 mg to 250 mg/L, likewise treatment with Alum decreased electrical conductivity from 1139 to 365 then increased to 612 µS/cm as dose increased. Observation in Chart 3 shows that before treatment the amount of total dissolved solid was above WHO recommended limit of 500 mg/L, but after treatment with MO and Alum the amount was reduced that later increased with the increase in doses.

Turbidity Content of Water

During turbidity analysis as indicated in Chart 4, it was observed that the use of MO and Alum was effective in turbidity reduction from 50 to 200 but at 250 mg/L there was a slight increase.

Although initial turbidity for water sample was 109 NTU that is beyond WHO recommended limit of 5 NTU but after treatment turbidity reduced to recommended limit.

Iron and Manganese Concentrations

The amounts of iron and manganese varied as the concentration of coagulants varied too as seen from Chart 5 and 6. During treatment with MO, iron and manganese decreased from 0.202 to 0.08 mg/L and 0.09 to 0.05 mg/L respectively. On treatment with Alum iron and manganese decreased in the range of 0.20 to 0.09 mg/L and 0.07 to 0.03 mg/L respectively.

Total Hardness Contents

From Chart 7 the total hardness of water samples before treatment was 130 mg/L, however after treatment ranged between 120 to 73 mg/L, which was within WHO standards.

Total Alkalinity Variations

The amount of alkalinity decreased gradually from 40 to 15 mg/L at 100 mg of MO as shown in Chart 8, beyond that alkalinity increased.

Chloride Content of Water

When water samples treated with MO and Alum solution as shown in Chart 9, the amount of chloride decreased from 26.94 to 5.83 mg/L and 26.94 to 0.9 mg/L respectively.

Observations on Total Coliforms

Analysis of total coliforms shows that treatment of water with MO and/or Alum was advantageous for reducing microbial load. The numbers of bacterial colonies reduced as the treatment dose increasing. After treatment total coliform count ranged between 12 count/100 mL to zero for MO and from 7 to zero count/100 mL for Alum which were within a permissible limit. Beyond 200 mg/L of MO and beyond 150 mg/L of Alum no colonies established.

DISCUSION

pH Variation of Water Samples

pH observations from Chart 1 suggests that at low concentrations of MO, cationic proteins bound alkaline ions leaving free hydrogen ions that resulted to low pH. At high MO concentration basic amino acids dominated by binding with acidic ions from water resulting in the release of hydroxyl group making the solution basic. Treatment with Alum changes water to more acidic that favors dissolution of heavy metals. Thus, use of Alum alone for water treatment is less recommended unless pH is monitored by addition of alkaline material.

Electrical Conductivity and TDS Measurements

The rapid dropping of electrical conductivity indicated in Chart 2 proved the effectiveness of treatment; increase in conductivity explains the increase in the free ions obtained after dissolution of salt, ionic proteins and ionization of water. Treatments with MO had a significant effect than compared to Alum. TDS observed after treatment from Chart 3 was within standard limit. This indicated that both MO seeds and Alum possess cationic polyelectrolyte that flocculate with a chemical compounds of basic polypeptides.

Turbidity Content of Water

The observed turbidity reduction was due to coagulant effects on negatively charged particles. The overdosing resulted in saturation of polymer bridge sites and caused destabilization of the particles due to insufficient number of particles to form more inter-particle bridges. The large positive charge and small size negative charges suggest that the main destabilization mechanism could be adsorption and charge neutralization.

Iron and Manganese Concentrations

After treatment of samples both iron and manganese reduced to within accepted WHO limit. MO shows high effectiveness in reducing iron than manganese compared to Alum salt.

Total Hardness Contents

Hardness reduction was because MO seeds contain polyelectrolyte it may therefore be hypothesized to remove hardness in water through adsorption and inter-particle bridging. Vijayaraghavan, (2011) also explained this phenomenon. It was further observed that total hardness increased with the increase in Alum doses since alum reacts with Ca/Mg and natural alkaline in the water forming insoluble compounds of calcium and magnesium sulphate. Alum is less recommended as it increases hardness.

Total Alkalinity Variations

The slight increase in alkalinity of water may be due to the increase in hydroxyl ions released by the basic amino acids of MO. Treatment with Alum resulted in alkalinity decrease as the doses increases, this is due to release of H^+ by Alum salt. In this case, Alum is the best for alkalinity reduction.

Chloride Content of Water

The amount of chloride decreased due to the presence of cations from MO and Alum salt that bonded to negatively charged chloride ions present in the water. Chloride obtained after treatment were within the recommended values 250 mg/L for drinking water. Thus, MO is useful for reduction of water salinity.

Observations on Total Coliforms

Total coliform reduction was therefore because MO is antimicrobial agent against microorganisms as similarly reported by Miquel and Wendy, (2010).

Conclusion and Recommendations

Results show that MO seeds powder is more effective for treatment of water than alum since MO is toxic free, eco-friendly, sustainable and cheaper. Observed that, the optimum dose of MO for turbidity reduction was 200 mg/L while with Alum no clearly optimum established value. Further studies on the role of MO towards increase in the pH and alkalinity of water at certain concentrations are recommendation in order to have scientific explanations in this matter.

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