Impact of Storage of *Moringa oleifera* Pod Powder on Turbidity Removal from Surface Water

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Abstract

This paper evaluated the consequences of storage of M. oleifera pod powder on its turbidity removal efficiency from synthetic raw water samples with low, medium and high turbidity values. The powder was stored at 28 ^{o}C for a period of 3 and 6 months. Optimum dose and pH of the stored pod powder extract were determined using jar test. For the powder stored over a period of 3 months, decrease in turbidity removal efficiency of 8, 3 and 9% for low, medium and high turbidity water samples whereas reduction in turbidity removal efficiency of 17, 12 and 19% for the pod powder stored over a period of 6 months were observed on the same water samples. The pH values were found to be within the range of 7.5 to 8.5. Therefore, M. oleifera pod powder can be prepared and stored for not more than 3 months in order to harness its full potentials in removing turbidity from surface water.

Keywords: *Moringa oleifera* pod; removal efficiency; surface water; synthetic raw water; turbidity

INTRODUCTION

The right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses (CESCR, 2002). Safe water is the doorway to health and health which is also a pre-requisite for progress, social equity and human dignity. Because of the essential role water plays in supporting lives, it also has, if contaminated, greater potentials for transmitting a wide variety of diseases and illnesses.

Access to safe drinking-water is a crucial issue because water-related diseases are one of the major health problems, especially in rural communities in developing countries. About three-quarter of world population currently lives in developing countries out of which 1.2 billion people still lack access to safe drinking water and more than 6 million children die from diarrheal diseases every year (Action Aid, 2010).

About 84% of the populations without access to an improved source of drinking water live in rural areas of developing countries (WHO and UNICEF, 2010). About one-third of people living in developing countries lack access to safe water, causing widespread suffering from typhoid, dysentery and many other diseases that cause loss of productivity (WHO and UNICEF, 2010). Lack of access to clean and sufficient amount of water makes people vulnerable to water-related diseases.

Studies have been undertaken on the use of plant-based materials such as *M. oleifera* seed extracts (Katayon *et al*., 2006) and *Tamarindus indica* crude pulp extract (Sa'id *et al*., 2016), etc., as natural coagulants for surface water clarification for drinking purpose for small communities in developing countries. It may be difficult to prepare such natural coagulants whenever there is need for its application in water treatment. In view of this, the powder of the coagulants can be prepared and stored under certain conditions prior to its use. However, the efficiency of the coagulant in removing turbidity from raw water may be adversely affected by storage duration and conditions. Therefore, this paper aimed at evaluating the effects of storing *M. oleifera* pod powder for the period of 3 and 6 months at 28 ^oC on its effectiveness in removing turbidity from surface water.

MATERIALS AND METHODS

Moringa oleifera Pod Powder

A large stock of *M. oleifera* pod was obtained from three villages of Warawa local Government area of Kano state, Nigeria, located on latitude 11.887193 and longitude 8.732286 which are; Carka, Warkai, and Jilmawa in January, 2016. The pods were harvested after reaching maturity on the parent tree with its inherent brownish colour. It was then screened by manual picking to isolate clean ones only. The selected ones were washed with water and dried under a shade. Then, it was manually grounded using domestic blender into powder and then sieved through 210 µm British Standard sieve.

Storage

The *M. oleifera* pod powder was divided into three for storage at a mean temperature of 28 ^oC for 3 and 6 months, respectively, and third portion was used immediately for control tests in the laboratory.

Oil Removal by Soxhlet Extraction

Oil removal was carried out in an Analytical Chemistry Laboratory at the Department of Pure and Industrial Chemistry, Bayero University, Kano, using electro-thermal Soxhlet with methanol as extraction solvent. On the process, 15 g of the powdered form of the pod was placed inside a thimble made from a thick filter paper which was loaded into the main chamber of the Soxhlet extractor. The extractor was then placed on a flask containing methanol. The Soxhlet was then equipped with a condenser.

The methanol was heated to reflux, its vapour travelled up a distillation arm and flowed into the chamber housing the thimble of the powder. The methanol vapour condensed and dripped down back into the chamber housing the powder. The chamber containing the solid material slowly filled up with warm solvent.

Some of the ingredients were then dissolved in the warm solvent by observing a yellow colouration in the warm methanol contained in the Soxhlet chamber. When the Soxhlet chamber filled up, it was automatically emptied by a siphon side arm with the methanol running back down to the distillation flask. This cycle was allowed to repeat several times until no colouration was observed in the Soxhlet chamber after which the system was turned off. The first batch of the powder was replaced by another 15 g and the system continued until a total of 70 grams weight of the thimble (press-cake) was obtained.

Extraction of Active Ingredients

The press-cake obtained after oil extraction was used to prepare the coagulants of various concentrations as described in Section 2.4. Generally, a known weight of the press-cake was dissolved in 100 ml of distilled water and the mixture was blended using a stirrer for about 10 minutes to dislodge the active coagulating agents. A GF type filter paper (7µm pore size) was then used to filter the suspension and the filtrate was used as a stock solution for the experiments (Okuda *et al.,* 1999).

Preparation of Coagulant

A percentage concentration that dissolves a weight into liquid was considered (% in weight/volume, w/v). The percentages here indicated the number of grams of powder contained in 100 ml of distilled water. Four percentage concentrations were considered (3, 5, 7 and 9%) by establishing a proportion with a known mass of the powder listed over the total quantity of distilled water.

Synthetic Raw Water

Synthetic turbid water samples were prepared for this study. The preparations were achieved by adding 10 g of kaolin clay into 1 L of distilled water. The suspension was then stirred slowly for 1 h for uniform dispersion of kaolin particles. After stirring phase, it was allowed to stand for 24 h for complete hydration of the kaolin particles as suggested by Eman and Suleiman (2010). This suspension was then used as the stock solution for the preparation of water samples of turbidity values of 100, 300 and 500 NTU, labelled as low, medium and high turbidities, respectively.

Optimization of Coagulant Dose

Dose optimization was carried out using jar test apparatus used for simulating coagulation-flocculation process in water treatment plant (Ndabigengesere *et al.,* 1995). A 500 ml of the synthetic turbid water was added into each of six beakers, each 1000 ml capacity. Arbitrarily selected doses of 1, 1.7, 3.3, 6.7, 10 and 13.3 ml doses of *M. oleifera* solution were added to the six beakers and stirred at 100 rpm for 2 minutes. The stirring speed was then reduced to 25 rpm and the mixing continued for 20 minutes. The experimental samples were then allowed to settle for about 30 minutes. After sedimentation, supernatant samples were collected from each beaker and tested for residual turbidity. All jar test experiments were carried out at room temperature because low temperature may have an adverse effect on coagulation and flocculation kinetics as suggested by Kang and Cleasby (1995).

Optimization of pH

The optimum dose of the extract obtained in section 3.5 was kept constant and the pH of the water samples was varied within the drinking-water range of 6.5 to 8.5 by adding drops of 0.1 M H_2SO_4 to create acidic pH and 0.1 M NaOH to create values in alkaline pH. The optimum pH value was that of the sample with the least amount of residual turbidity.

RESULTS AND DISCUSSION

Effect of 3 Months Storage Duration of *M. oleifera* Pod Powder on its Turbidity Removal

The results of the turbidity removal efficiency for the powder stored for a period of 3 months was obtained and compared to the removal efficiency of the control test with no storage. The comparison revealed a reduction in turbidity removal efficiency as follows. Removal efficiency of 80 to 70%, 81 to 60% and 79 to 58% for low, medium and high turbidity water samples, respectively (see Figure 1).

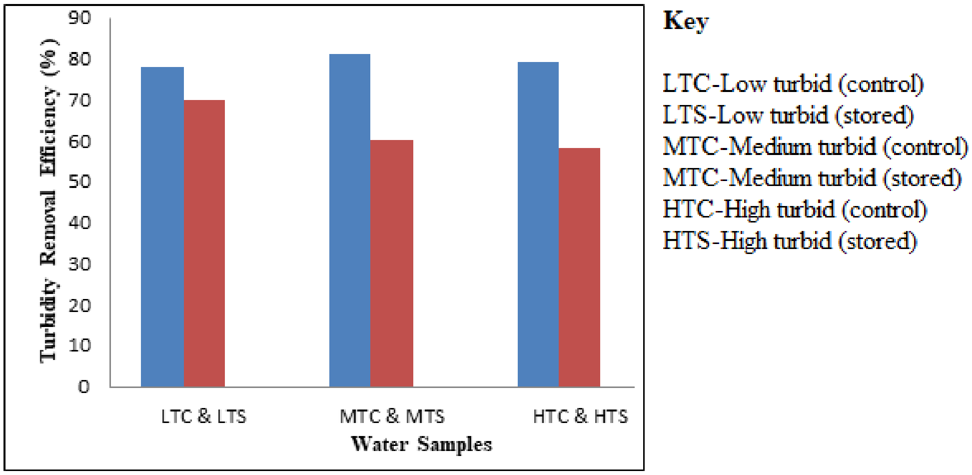

Figure 1: Variation of turbidity removal efficiency of *M. oleifera* pod powder stored for 3 months

Effect of 6 Months Storage Duration of *M. oleifera* Pod Powder on Turbidity Removal

When 9% stock solution of the powder stored for a period of 6 months was used to treat low, medium and high turbidity water samples, 65, 55 and 53% turbidity removal efficiencies were obtained compared to the control test with removal efficiencies of 78, 81 and 79% for low, medium and high turbidity water samples, respectively (Figure 2).

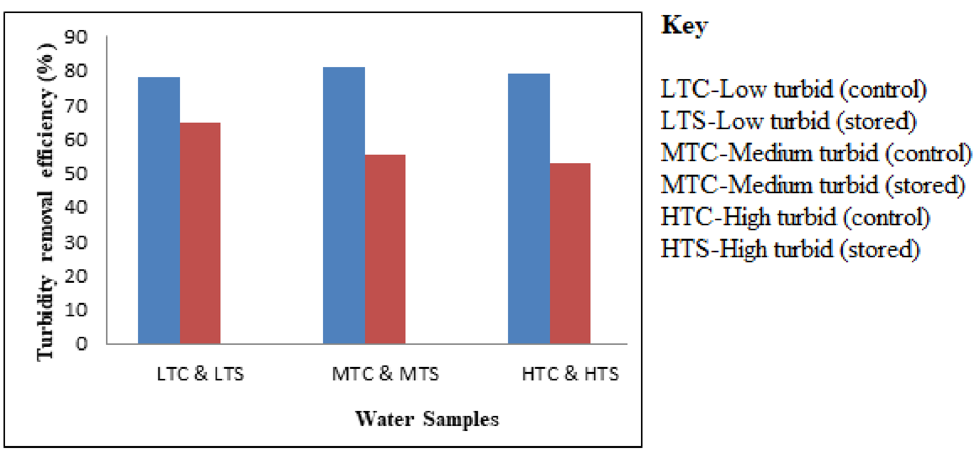

Figure 2: Variation of turbidity removal efficiency of *M.oleifera* pod powder stored for 6 months

Optimum pH of *M. oleifera* Pod Powder Stored for 3 months

This section presents the pH values of *M.oleifera* pod extract at which maximum turbidity removal was obtained. The optimum doses for 3, 5, 7 and 9% concentrations obtained by altering the pH values within the World Health Organization's range of 6.5 to 8.5. The Figure below represented the result of optimum pH when treated with the above percentage concentration using the optimum dose of 297 mg/l obtained for low turbidity water sample and 153 mg/l for medium and high turbidity water samples as obtained in section 4.1. The optimum pH values were 8 for low and 8.5 for both medium and high turbidity water samples.

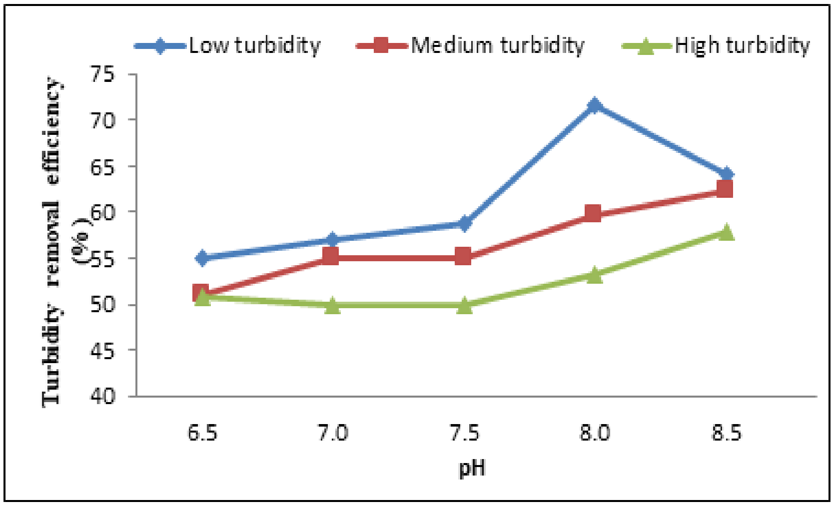

Figure 3: Variation of turbidity removal with pH of water samples

Optimum pH of stored *M.oleifera* pod powder for a period of 6 months

The highest turbidity removals recorded for the three set of turbid waters were found at pH values of 8.5 with turbidity removals of 66, 55 and 53%, respectively.

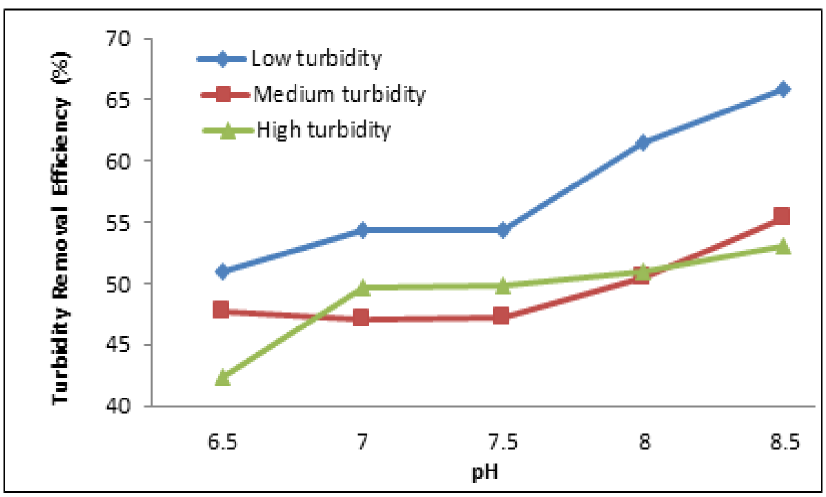

Figure 4: Variation of turbidity removal efficiency with pH of the water samples

CONCLUSION

The performance of the pod powder decreased over time from the observations made. For the powder stored over a period of three months, a change in turbidity removal efficiency of 8, 3 and

9% were observed. On the other hand, a change in turbidity removal efficiency of 17, 12 and 19% were observed for the samples stored over a period of 6 months for the set of water used. The optimum value of pH required for coagulation with the stored *M.oleifera* pod powder is 7.5 to 8.5 for the samples of water used, this implies a low turbidity removal at the lowest selected pH value of 6.5. *M.oleifera* pod powder can be stored and used within 3 months from harvesting. The effects of storage conditions on aqueous extract of *M.oleifera* pod powder on its coagulation efficiency may need further studies.

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