



EFFECTS OF STORAGE OF *Moringa oleifera* SEED POWDER ON TURBIDITY REMOVAL FROM MEDIUM TURBID WATER

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ABSTRACT

Processed *Moringa oleifera* seeds are used as one of the alternative natural coagulants for turbidity removal from surface water. This paper investigated the influence of storage of *M. oleifera* seed powder on its turbidity removal from river water. *M. oleifera* seed powder stored indoors and outdoors each from 0 to 6 months were used to treat river water of medium turbidity (30 to 104 NTU). Three stock solutions of *M. oleifera* seed powder (i.e. 0.2, 0.4, and 0.6 % w/v) were used to conduct Jar test on the water samples. *M. oleifera* seed powder stored indoors and outdoors attained excellent turbidity removal with efficiency ranging from 92 to 100% at coagulant dose ranging from 320 to 2400 mg/L with pH of the treated water ranging from about 7 to 8. *M. oleifera* seed powder can be prepared and stored for 3 to 6 months from harvest while still achieving very good turbidity removal efficiency.

Keywords: Medium turbidity; *Moringa oleifera* seed; raw water; storage; turbidity removal.

INTRODUCTION

Water is a basic human need and lack of access to clean potable water is a major cause of water-related diseases in low-income countries. The quality and quantity of water used for households is an important aspect of domestic water supplies, which influences personal hygiene and public health. Water of improved quality is usually obtained by treating raw water to improve clarity, taste and odour, or to remove harmful organisms (Egbuikwem and Sangodoyin, 2013; Guy and Jamie, 2003).

Despite the remarkable improvement achieved in the provision and access to safe drinking-water over the past decades in many parts of the world, approximately one billion people still lack access to clean water (Guy and Jamie, 2003). Developing countries face potable water supply problems because of inadequate financial resources. The cost of water treatment is increasing and the quality of river water is not stable due to turbidity caused by suspended and colloidal particles resulting from surface runoff into surface water bodies during or after rainfall. In some tropical developing countries, clarification of turbid river water using locally-available plant-based materials as coagulants is an ancient and common practice. Of the many plant materials investigated, seeds of *Moringa oleifera* is one of the effective sources of coagulant for water treatment (see Varkey, 2020; Okuda and Ali, 2019; Halkade and Pise, 2013), containing active agents with good

coagulation ability. The extract of the seed has been used to remove hardness from water (Muyibi and Evison, 1995).

Abaliwano *et al.*, (2008) reported that *M. oleifera* seed is an effective coagulant comparable to the much used synthetic chemical coagulants such as aluminium and iron salts.

Therefore, this study investigated the influence of storing *M. oleifera* seed powder on turbidity removal from river water with a view to obtaining optimum coagulation dose for certain storage period within 6 months.

MATERIALS AND METHODS

Moringa oleifera Seed Powder Preparation

M. oleifera seeds were procured from "Muda-Lawan" market, Bauchi City in northeast Nigeria. The seeds were de-husked manually with the aid of mortar and pestle; the clean kernels were then milled into fine powder with the aid of a manual grinding machine, the powder was sieved through 210 µm BS sieve as described by Bichi (2013); Alo *et al.* (2012) and Bichi *et al.* (2012).

Defatting by Soxhlet Extraction

Soxhlet extraction method was used to defat oil from 200 g of *M. oleifera* seed powder using electro-thermal (heating mantle, model MG3868) using n-Hexane as the extracting solvent.

The extracted powder was air-dried for 24 h to allow n-Hexane to evaporate and then 164 g was obtained.

Storage of the Prepared Powder

The defatted *M. oleifera* seed powder was divided into two portions; each portion was packaged and sealed in a separate polythene bag. The first package was stored in the Laboratory and labeled "indoor storage", while the second package placed at a weather station outside and labeled "outdoor storage". The Laboratory and weather station with coordinate 10.418754, 9.880764 are sited at the water treatment plant near Gubi Dam, about 14 km north of Bauchi City. The Laboratory provides water quality analyses to Bauchi State Water Board. See Wufem *et al.* (2009) for more details on Gubi Dam.

The prepared powders were stored under conditions mentioned earlier between February and June, 2016. Temperature, pressure, humidity, rainfall, and wind speed ranged from 19 to 41 °C, 752 to 764 mmHg, 7 to 79%, 0 to 7.6 mm, and 0 to 11 m/s, respectively. These meteorological information was obtained from the daily record of the above parameters at the weather station.

Coagulant Stock Solution

Stock solution of *M. oleifera* seed powder was prepared by placing 2, 4, and 6 g each of the seed powder into conical flasks with each flask containing 100 mL of distilled water. The mixture in each flask was shaken three times (for 2 mins each) at intervals of 5 mins for proper dissolution of the powder to obtain 0.2, 0.4 and 0.6% w/v stock solution, respectively. The solutions were then filtered using muslin cloth (Hitendra *et al.*, 2012; Katayon *et al.*, 2006).

Collection of Raw River Water

Medium turbid raw water sample with turbidity ranging from 30 to 104 NTU was collected on each experiment day in a 15 L sterilized plastic container (as specified by Katayon *et al.*, 2004) from a stream tributary located around Gubi village. The stream supplies water to villages downstream of the Gubi Dam that have no access to municipal water supply. A photometer (Model 7100, Palintest, England) was used to measure the turbidity level of the raw water in

duplicates.

Coagulant Dose

Four 1 L capacity beakers were filled with the turbid raw water sample to 250 mL mark. A portion of the prepared 0.2 w/v stock solution (i.e. 40, 60, 80 and 100 mL) was added to raw water to obtain mass concentration of 320, 640, 960 and 1280 mg/L, respectively. This procedure was repeated for the 0.4 and 0.6% w/v stock solutions, respectively.

Jar Test

Dose optimization was carried out using jar test apparatus according to Ndabigengesere *et al.*, (1995). About 500 mL of the raw water was added into each of six 1 L capacity beakers each having one of the coagulant doses presented earlier. The beakers were stirred at 100 rpm for 2 mins. The speed was then reduced to 25 rpm and the mixing continued for 20 mins. The samples were then allowed to settle for about 30 mins. After settling, supernatant samples were collected from each beaker and tested for residual turbidity. The optimum dose of the *M. oleifera* seed powder was that of the sample with the least amount of residual turbidity after carrying out the Jar test.

Statistical Analysis

One-way analysis of variance (ANOVA) was employed to test the significance of variation of turbidity removal efficiency and pH between storage durations and conditions using Data Analysis in Microsoft Excel 2013.

RESULTS AND DISCUSSION

Effect of Storage Condition on Performance of *M. oleifera* Seed Powder

Coagulation of medium turbid water with *M. oleifera* seed powder extract 0.2, 0.4 and 0.6% w/v resulted in turbidity removal efficiency ranging from about 93 to 100% and 92 to 100% under indoors and outdoors storage conditions, respectively, for the duration of 0, 3 and 6 months (denoted as t₀, t₃ and t₆; Figures 1 and 2). The *M. oleifera* powder stored indoors achieved slightly higher turbidity removal efficiency than that stored outdoors. This might be due to direct impact of environmental effects on the powder as previously reported by Katayon *et al.* (2004).

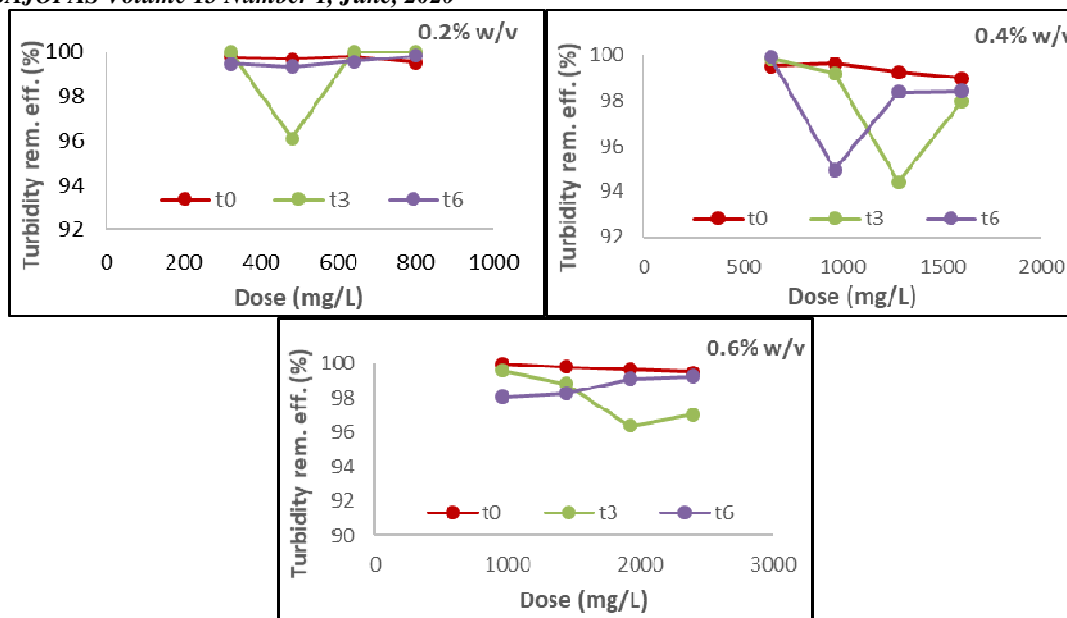


Figure 1: Turbidity removal efficiency of *M. oleifera* seed powder stored indoors for 0, 3 and 6 months.

Effect of Storage Duration of *M. oleifera* Seed Powder on Turbidity Removal

With respect to storage duration, the turbidity removal efficiencies of the *M. oleifera* powder at 0.2, 0.4 and 0.6% w/v ranged from 97.7 to 99.7%, 94.3 to 99.5%, and 93.2 to 100% at the start, after 3 and 6 months, respectively (Figure 2).

Lowest turbidity removal efficiencies were obtained at 3 months storage whereas highest values (i.e. 100% at 0.2% w/v in Figure 1) were recorded at the beginning of the storage duration. One-way analysis of variance (ANOVA) conducted on the turbidity removal efficiencies of 0.2, 0.4 and 0.6% w/v seed powder stored indoors and outdoors revealed no significant and significant difference, respectively, across storage durations (with respective mean p -

values = 0.44 and 0.02, at $\alpha = 0.05$).

Similar findings were reported by Noor *et al.*, (2012) while investigating the coagulating ability of spray-dried salt-extracted *M. oleifera* seeds powder under different storage conditions. Interestingly, 6-month storage achieved higher turbidity removal efficiencies than 3-month with almost similar removal efficiencies between the freshly prepared and 6-month stored seed powders at some points, regardless of storage condition (see Figures 1 and 2).

This trend may possibly be due to disintegration and formation of active ingredients after about 3 and 6 months, respectively, resulting in improved turbidity removal efficiency after 6 months of storage. The turbidity removal efficiency found in this study are similar to those reported by Noor *et al.* (2012).

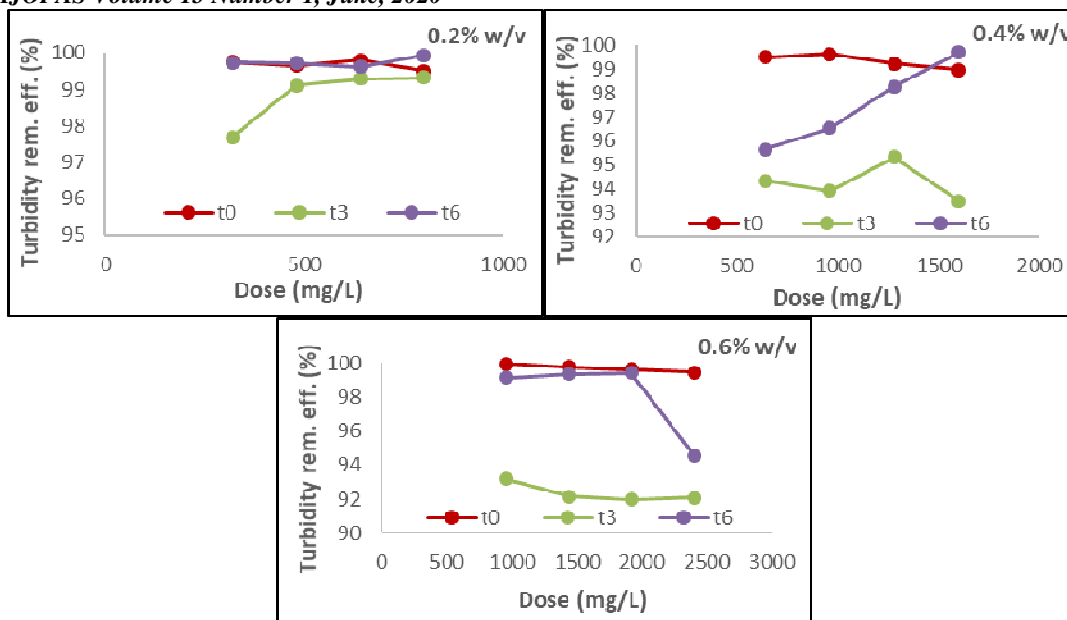


Figure 2: Turbidity removal efficiency of *M. oleifera* seed powder stored outdoors for 0, 3 and 6 months

Effect of Storage Condition and Duration on pH of *M. oleifera* Seed Extract

The pH values of the extract obtained from the indoor- and outdoor-stored *M. oleifera*

seed powder are shown in Figures 3 and 4. The pH ranged from 7.7 to 9.3, 7.4 to 7.9 and 7.4 to 7.7 at 0.2, 0.4 and 0.6% w/v of the *M. oleifera* seed extract, respectively.

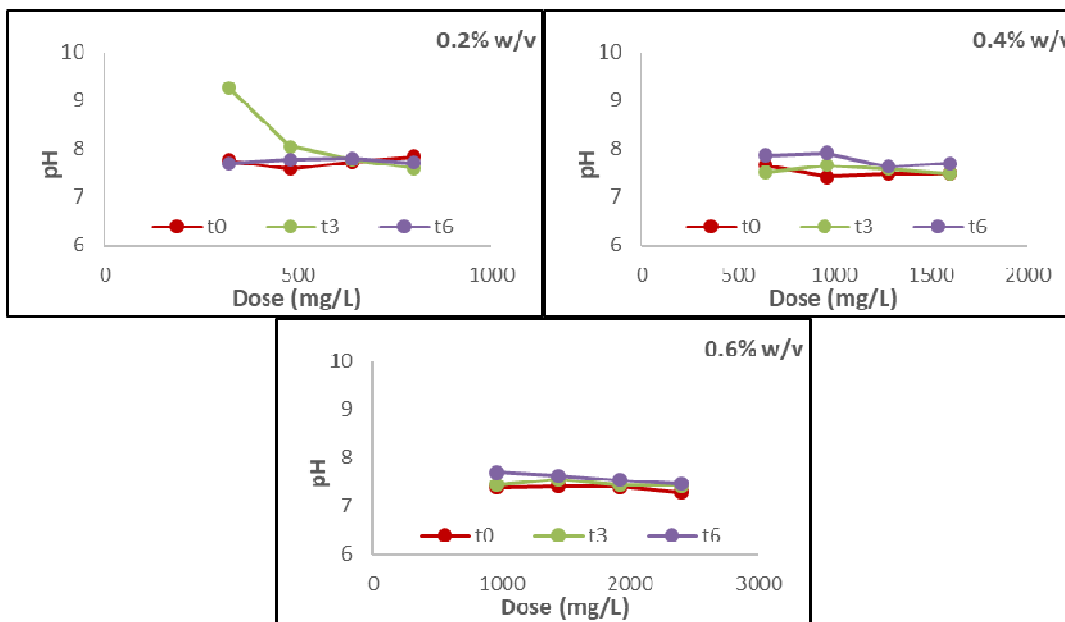


Figure 3: Variation of pH with dose of *M. oleifera* seed powder stored indoors for 0, 3 and 6 months.

All of the coagulation pH values fall within the drinking-water range of 6.5 to 8.5 recommended by WHO (2011) regardless of storage condition except for 0.2% w/v stored for 3 months, appearing to be an outlier. Noteworthy, pH values ranging from 6.95 to 7.84 were obtained

when the seed powder was stored outdoors. These values are generally lower than those obtained with indoor storage. As expected, the treated water does not require pH adjustment before consumption, after satisfying other drinking-water quality characteristics.

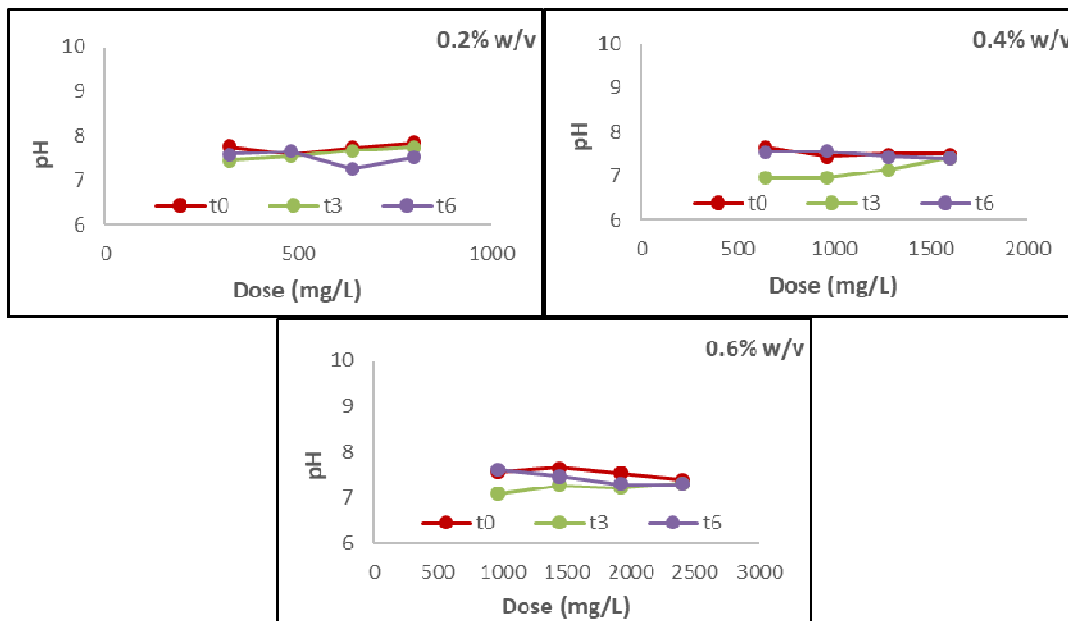


Figure 4: Variation of pH with coagulant dose of *M. oleifera* seed powder stored outdoors for 0, 3 and 6 months.

One-way ANOVA conducted on the pH values of the *M. oleifera* seed extracts at 0.4 and 0.6% w/v revealed significant difference across storage durations, regardless of storage conditions (mean p -value = 0.01 at $\alpha = 0.05$). However, the pH values of the seed powder at 0.2% w/v were not significantly different (mean p -value = 0.26 at $\alpha = 0.05$).

CONCLUSION

Extract of *Moringa oleifera* seed powder excellently removed turbidity from river water of medium turbidity with removal efficiency ranging from 92 to 100% under indoor and outdoor storage conditions. There was no significant difference in turbidity removal efficiency with the

powder stored indoors from 0 to 6 months. However, there was significant difference in turbidity removal efficiency with the powder stored outdoors for the same duration.

The pH of the treated water varied significantly at or above 0.4% w/v *M. oleifera* seed extract concentration, with values mostly within the drinking-water range of 6.5 to 8.5. Therefore, *M. oleifera* seed powder can be prepared and stored for 3 to 6 months from harvest while still achieving very good turbidity removal efficiency. Effects of storage conditions on *M. oleifera* seed powder on turbidity removal efficiency using other extraction techniques such as spray-drying and salt extraction may require further studies.

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