Original Research Article

Application of *Moringa oleifera* powder and seeds to remove turbidity from water

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Aims: The use of natural, on-site, low-cost coagulants can reduce problems related to the consumption of non-potable water and untreated wastewater discharges into receiving bodies. A natural solution for acting as a coagulant is the *Moringa oleifera* seed. The objective of this study is to analyze the efficiency of turbidity removal through the application of moringa seeds as a natural coagulant in three different retention times.
Methodology: The research was carried out at the Agricultural Products Storage Processing Laboratory of the Federal University of Campina Grande. The powder obtained after trituration of the seeds and the seed without bark was used. A jar test was used to test the application of the coagulant based on powder and moringa seeds. To obtain artificial water, 0.5 g of clay was added to the jars of the jar test. The Jar Test was connected to a rotation of 120 rpm for 30 minutes, then was turned off and kept at rest for 45, 53 and 61 minutes. Subsequently, approximately 50 mL of sample was collected from each pitcher for analysis of the turbidity parameter.
Results: The application of the seeds was more efficient than the powder. Sedimentation times influenced the removal of turbidity.
Conclusion: The turbidity values are outside of what is allowed by current Brazilian legislation.

Keywords: Coagulant; efficiency; plants; water treatment.

1. INTRODUCTION

Water is necessary for the economic, social and political development of a country. Due to the hydrological cycle, water is renewable, but because it is too contaminated in its springs, it undergoes a process of potability, which can often require a high investment. For a long time, the conventional water treatment process has been known, which transforms

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freshwater into drinking water, when submitted to processing, usually called classic or complete, performed in a conventional water treatment plant [1].

The most commonly used coagulants in water treatment plants (ETAs) are inorganic, trivalent salts of iron and aluminium or synthetic polymers. Despite the proven performance and cost-effectiveness of chemical coagulants, natural coagulants/flocculants are being studied, of which some biopolymers are being investigated more intensively, as is the case of *M. oleifera* [2].

Among the coagulants, the most commonly used are aluminium sulphate and ferric chloride. Ndabigengesere and Narasiah [3] have pointed to several drawbacks of the use of aluminium salts, such as Alzheimer's disease and similar health problems associated with residual aluminium in treated waters. According to Ghebremichael [4], when compared to chemical coagulants, moringa seed has several advantages, among them: reduced need for pH readjustment, low operation cost and reduced sludge volumes.

Moringa seeds have been widely used to remove water turbidity for drinking purposes, especially in rural communities where water treatment does not occur [5]. In places where there is no water supply through the distribution network or where there are no improved water sources, it is possible to treat water at the point of use to make it safer for human consumption. An alternative that can be used, in certain situations, is the application of *Moringa oleifera* seed powder to clarify turbid waters.

The use of moringa seeds for water purification is an economical alternative. A small dosage of this biopolymer can greatly reduce the consumption of chemical coagulants, making it a viable alternative in water treatment to chemical coagulants due to its coagulant properties and its ability to remove bacteria [6].

Due to its versatility, the moringa presents effective action on various types of water, as well as various types of effluents. The methods of application of natural coagulants in water are still empirical, requiring scientific work to prove its effectiveness in water treatment. The objective of this study is to analyze the efficiency of turbidity removal through the application of moringa seeds as a natural coagulant in three different retention times.

2. MATERIAL AND METHODS

2.1. Research venue

The research was carried out at the Agricultural Products Storage Processing Laboratory of the Federal University of Campina Grande, Paraiba. Two different methods of coagulant application were tested.

2.2. Preparation of coagulant

The first was the direct method with the application of seeds without peel, which was peeled manually before application. To obtain the powder, the seeds were crushed in a domestic blender.

2.3. Application of coagulant

Initially, the water was characterized by high turbidity, using distilled water, to be compared with the water after the application of the coagulant. A jar test was used for the coagulant application tests based on powder and moringa seeds. In the jar test, 12 g of powder and seeds were introduced to 500 mL of water with turbidity obtained by adding 0.5 g of clay (Table 1).

Table 1. Initial characterization of water with high turbidity.

Parameter	Standard (distilled water)	Addition of 0.5 g of clay
Turbidity (NTU*)	0.09	287

*Note: *Nephelometric turbidity unit.*

The equipment was connected to a rotation of 120 rpm for 30 minutes, then was turned off and kept at rest for 45, 53 and 61 minutes. Subsequently, approximately 50 mL of sample was collected from each Jar Test pitcher for analysis of the turbidity parameter, to verify the removal efficiency by comparing the results with the water before treatment. The turbidity analysis of the samples was the portable equipment using a micro processed digital turbidimeter model DLT-WV.

3. RESULTS AND DISCUSSION

The coagulant obtained from the seeds of *M. oleifera*, usually, presents satisfactory results regarding the removal of turbidity, achieving reductions of 80 to 99% for this parameter [7]. However, in the course of the study, there were large variations in the percentage of removal (Figure 1).

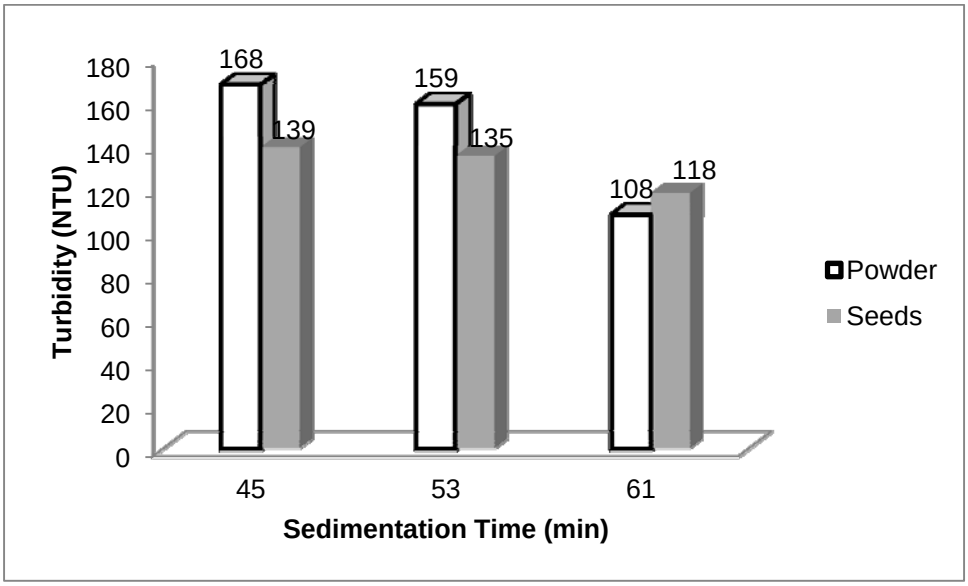

Fig. 1. Removal of water turbidity with the application of powder and moringa seeds.

The application of the powder presented removal efficiency of 41.46, 44.6 and 62.37%, respectively, for the sedimentation times studied, while the seeds presented efficiency of 51.57, 52.96 and 58.88% of efficiency in removing this parameter, being more efficient than the powder.

It was observed that the sedimentation times influenced the turbidity removal, since, with the gradual increase of the sedimentation time, the turbidity decreased. However, the turbidity values are outside of what is allowed by current legislation. Ordinance N^{o}. 5/2017 of the Ministry of Health establishes a maximum value of 5.0 NTU for turbidity in water considered potable [8].

Pereira et al. [9] verified that for the removal of turbidity the solution containing *Moringa oleifera* presented better values for 100 NTU, obtaining a reduction of 70.67%, for the time of 30 minutes, and for 150 NTU reducing 56%, in the time of 10 minutes. Muniz et al. [10] when studying the use of moringa seeds in the removal of water turbidity found that the seeds without bark provided a reduction from 400 to 0.8 NTU. Lo Monaco et al. [11] when evaluating the sedimentation times of 2 and 24 h observed that the time of 24 h provides greater reductions in water turbidity. Pritchard et al. [12] obtained, using moringa seeds confined in sachets in the treatment of water with a turbidity of 146 UNT, a reduction in turbidity of approximately 85% in sedimentation tests.

Moringa has not been applied as a primary coagulant only in the treatment of natural surface water, but also in wastewater from domestic and industrial effluents. In the treatment of industrial effluents, Song et al. [13] evaluated residual water from tanneries by applying *Moringa oleifera* in the removal of suspended solids (30-37%) and chromium (38-46%).

A negligible interference characteristic has also been demonstrated in the effluent pH values. The results obtained support the hypothesis that the use of natural coagulant from Moringa oleifera seeds may be satisfactory in the treatment of textile effluents by restricting the use of chemical substances, such as aluminium sulphate [14].

4. CONCLUSION

The objective of the study was to analyze the efficiency of turbidity removal through the application of moringa seeds as a natural coagulant in three different retention times. The study revealed that there were large variations in the efficiency of turbidity removal. Seed application was more efficient than dust. The sedimentation times influenced the turbidity removal because, with the gradual increase of the sedimentation time, the turbidity decreased. Based on the conditions under which the survey was conducted, the turbidity values are outside the scope of current legislation.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS

Semirames do N. Silva developed the following research. Suiane M. Moraes and Joana D'arc P. Matos were responsible for the bibliographic review. Roberta de S. O. Wanderley, Luís P. F. R. Silva and Antônio J. R. Barroso assist in conducting the analysis and interpretation of the data obtained in the research and Josivanda P. Gomes, research supervisor.

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