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Qualidade de água tratada com sementes de *Moringa oleifera* Lam

Quality of water treated with *Moringa oleifera* Lam seeds

Calidad del agua tratada con semillas de *Moringa oleifera* Lam

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Resumo

Teve-se como objetivo avaliar a qualidade química e microbiológica da água de cisternas rurais antes e após o tratamento com sementes de *Moringa oleifera* Lam. As sementes de moringa utilizadas no trabalho foram adquiridas no município de Cajazeiras. O coagulante da moringa foi obtido em meio aquoso. A água utilizada no trabalho foi oriunda de cisternas construídas no assentamento Santo Antônio, município de Cajazeiras. A água utilizada foi

analisada antes e após o tratamento. Foram realizadas as análise dos parâmetros: pH, condutividade elétrica, alcalinidade total, resíduo provável e sólidos dissolvidos totais no Laboratório de Água e Solo e no Laboratório de Microbiologia do Instituto Federal de Educação, Ciência e Tecnologia da Paraíba Campus Sousa foram realizadas as análises de coliformes fecais e *Escherichia coli*. Todas as análises dos parâmetros químicos apresentaram diferenças significativas antes e após o tratamento. Os tratamentos C1 e C5 apresentaram presença de *Escherichia coli*, os demais tratamentos apresentaram ausência de *E. coli*.

Palavras-chave: água; moringa; semente; tratamento.

Abstract

The purpose of this work was to evaluate the chemical and microbiological quality of water from rural cisterns before and after the treatment with *Moringa oleifera* Lam seeds. The moringa seeds used in the work were acquired in the municipality of Cajazeiras. The moringa coagulant was obtained in aqueous medium. The water used in the work came from cisterns built in the Santo Antonio settlement, municipality of Cajazeiras. The water used was analyzed before and after the treatment. The analysis of parameters: pH, electrical conductivity, total alkalinity, probable residue and total dissolved solids were performed in the Water and Soil Laboratory and the Microbiology Laboratory of Federal Institute of Education, Science and Technology of Paraiba Campus Sousa analyses of fecal coliforms and *Escherichia coli* were performed. All analyses of chemical parameters showed significant differences before and after treatment. Treatments C1 and C5 showed presence of *Escherichia coli*, the other treatments showed absence of *E. coli*.

Keywords: water; moringa; seed; treatment.

Resumen

El propósito de este trabajo fue evaluar la calidad química y microbiológica del agua de las cisternas rurales antes y después del tratamiento con semillas de *Moringa oleifera* Lam. Las semillas de moringa utilizadas en el trabajo fueron adquiridas en el Municipio de Cajazeiras. El coagulante moringa se obtuvo en medio acuoso. El agua utilizada en la obra provenía de cisternas construidas en el asentamiento de Santo Antonio, municipio de Cajazeiras. El agua utilizada fue analizada antes y después del tratamiento. El análisis de los parámetros: pH, conductividad eléctrica, alcalinidad total, residuo probable y total de sólidos disueltos se realizó en el Laboratorio de Aguas y Suelos y en el Laboratorio de Microbiología del Instituto Federal de Educación, Ciencia y Tecnología de Paraiba Campus Sousa se realizaron análisis de coliformes fecales y *Escherichia coli*. Todos los análisis de los parámetros químicos mostraron diferencias significativas antes y después del tratamiento. Los tratamientos C1 y C5 mostraron la presencia de *Escherichia coli*, los otros tratamientos mostraron la ausencia de *E. coli*.

Palabras clave: agua; moringa; semilla; tratamiento.

1. Introduction

Environmental and human health contraindications presented by the use of chemical compounds in wastewater treatment or drinking water production are becoming more and more frequent. Aluminum sulfate stands out as the chemical coagulant most used in Brazil, due to its good efficiency and low cost. However, as aluminum is not biodegradable, high concentrations of this compound can cause problems to human health, including the acceleration of the degenerative process of Alzheimer's disease (Bondy, 2015).

With the quality and quantity of fresh drinking water available to supply the world's population compromised, alternative treatments are needed to ensure the quality of treated water (Pereira, 2011). Thus, several coagulants are being used to remove color and turbidity from raw water in order to make it drinkable.

In this context, an environmentally correct and accessible coagulant presents itself as a viable alternative for water treatment. Therefore, many plants are being used as natural coagulants and/or flocculants, as is the case with the moringa. In view of the above, the objective was to evaluate the chemical and microbiological quality of water from rural cisterns before and after the treatment with *Moringa oleifera* Lam seeds.

2. Material and Methods

The moringa seeds were purchased in the municipality of Cajazeiras, state of Paraiba. The moringa coagulant was obtained in aqueous medium. In a beaker 150 mL of distilled water and 1.5 g of moringa seed powder were added. Then the solution was homogenized with the aid of a mixer in a rotation of 1000 rpm for 30 minutes.

The water used in the work came from cisterns built at the Santo Antonio settlement, municipality of Cajazeiras, Paraiba. The source of the water from the cisterns during this period is a reservoir located at the settlement itself. The water used in the experiment was analyzed before and after treatment at the Microbiology Laboratory of Federal Institute of Education, Science and Technology of Paraiba Campus Sousa to verify fecal coliforms and *Escherichia coli*.

In the coagulation/flocculation using the moringa seed powder, 250 mL of water from the cisterns were placed in five 250 mL Erlenmeyer flask on a conventional stirring table.

Then the 2.5 mL concentration of the coagulant was added to each one. The coagulation/flocculation time was 30 min, this procedure was performed in triplicate.

After the coagulation/flocculation test, the agitator was turned off and the samples were kept at rest for 45 min, so that decantation/sedimentation of the flocculated material occurred. Then, the analysis of the parameters: pH, electrical conductivity, total alkalinity, probable residue and total dissolved solids were performed in the Water and Soil laboratory of Federal Institute of Education, Science and Technology of Paraiba Campus Sousa.

3. Results and Discussion

Table 1 shows the results obtained for the chemical analyses of the water before and after the treatment with the use of the coagulant.

Table 1. Results of water analysis before and after coagulant treatment.

Treatments	**Analysis before treatment**				**Analysis after treatment**			
(Cisterns)	pH	CE	ALC	Res. P	pH	CE	ALC	Res. P
C1	6.23c	0.15c	83.25c	1073.33c	7.01c	0.15c	85.00b	1067.66c
C2	7.00bc	0.12d	74.40d	860.00d	7.50b	0.12d	67.00c	884.00d
C3	7.36bc	0.11d	74.06d	797.00d	7.53b	0.11d	66.00c	850.33d
C4	8.63a	0.35a	162.61a	2330.00a	8.30a	0.34a	147.00a	2272.33a
C5	8.16ab	0.22b	114.13b	1490.00b	7.56b	0.21b	94.33b	1494.00b
DMS	1.17	0.01	7.76	96.35	0.26	0.006	10.11	39.35
CV (%)	5.84	3.02	2.84	2.73	1.29	1.20	4.09	1.11

The averages followed by the same letter do not differ statistically from each other. DMS: significant average deviation; CV: coefficient of variation; Electrical conductivity (EC); Total alkalinity (CLA); Probable residue (P-res).

It is noted that all analyses showed significant differences before and after treatment. The pH of the water in the five cisterns before treatment varied from low acidity (6.23) to high alkalinity (8.63). However, after treatment with the use of coagulant obtained from moringa seed powder, the pH of the water varied from neutral (7.01) to high alkalinity (8.30), observing a decrease in these values after treatment. It is noticeable that the use of the coagulant brought the pH of the water closer to neutrality, which is recommended for human consumption.

It is observed, however, that the pH of the treated water was practically constant, as expected with the use of moringa as a coagulating agent (Franco et al., 2017). Santos et al. (2013) did not obtain significant pH variations using the moringa seeds in water. This, in practice, implies the reduction of costs with the addition of chemicals for pH correction when other substances are used in water treatment such as aluminum sulfate.

Values recommended by WHO pH 7 to 8.5 for raw water and 6.5 to 8.5 for treated water as eye irritation and exacerbation of skin problems occur when more than 11. Since Moringa oleifera is a natural product, its application, mainly in wastewater, is described as promising, as it can reduce the cost of chemicals used in pH adjustment (Bhatti et al., 2007).

The EC remained virtually the same after treatment. However, these values are within the WHO required limit of 1 dS/m (Brazil, 2017). The total alkalinity of water is given by the sum of the different existing forms of alkalinity, i.e., it is the concentration of hydroxides, carbonates and bicarbonates, expressed in terms of calcium carbonate. It can be said that alkalinity measures the capacity of water to neutralize acids. Most natural waters present alkalinity values in the range of 30 to 500 mg/L of $CaCO_3$, which is the unit used to express this parameter.

It is observed in the present study that the alkalinity of the water before treatment varied from 74.06 to 162.61 mg/L, after treatment it is observed that the C2, C3, C4 and C5 treatments decreased with the use of the natural coagulant extracted from the powder of moringa seeds, different from what occurred with the C1 treatment, where an increase from 83.25 before treatment to 85.00 after treatment was observed. High alkalinity waters are unpleasant to the palate and the association with high pH, excess hardness and dissolved solids, on the whole, can be harmful.

After the treatment, there is a decrease in the values of the probable residue for treatments C1 and C4, the inverse is observed in treatments C2, C3 and C5, where an increase in the values is noticed. The legislation establishes the maximum permitted residue of 1000 mg/L. However, it is observed that treatments C1, C4 and C5 are outside this maximum permitted limit. The C4 and C5 treatments present the highest averages, this probably occurred because the water used to supply the cisterns was water collected from a weir by water tank cars.

There is an increase in the mean values of Total Dissolved Solids after water treatment (Table 2). The presence of high levels of SDT in water can be unpleasant for consumers. The palatability of water with a level of SDT below 600 mg/L as found in this survey is generally considered good; drinking water becomes increasingly intractable for SDT levels above 1200

mg/L. As more total dissolved solids are added, water conductivity increases. High values can indicate corrosive characteristics of water.

With regard to public water supply, Ordinance number 5/2017 of the Ministry of Health establishes as the standard of potability 1.000 mg/L of total dissolved solids. In the case of CONAMA Resolution Nº 357, the maximum value is 500 mg/L for fresh waters class 1, 2 and 3. This also applies to irrigation water, since excess dissolved solids can lead to serious soil salinization problems. The presence of total dissolved solids is also related to the electrical conductivity of the water.

Table 2. Results for Total Dissolved Solids.

Total Dissolved Solids ($NaCl + CaCO_3$) (mg/L)		
Treatments	**Before the treatment**	**After the treatment**
C1	127.86	234.9
C2	102.96	193.13
C3	98.27	179.53
C4	306.17	483.66
C5	193.94	307.33

Tables 3 and 4 show the results of microbiological water analysis before and after coagulant treatment obtained from moringa seed powder. The result for fecal coliforms remained the same after the treatment of the water with the clotting agent. The drinking water must be free of pathogenic microorganisms and bacteria that indicate fecal contamination.

According to the Ministry of Health's Ordinance number 5, the presence of coliforms in water indicates contamination, with the potential risk of the presence of pathogenic organisms, and since they are more resistant in water than pathogenic bacteria of intestinal origin.

Table 3. Results of the analysis for fecal coliforms before and after water treatment.

Fecal coliforms		
Treatments	**Before the treatment**	**After the treatment**
C1	35º C> 1.1 x 10^3	35º C> 1.1 x 10^3
C2	35º C> 1.1 x 10^3	35º C> 1.1 x 10^3
C3	35º C> 1.1 x 10^3	35º C> 1.1 x 10^3
C4	35º C> 1.1 x 10^3	35º C> 1.1 x 10^3
C5	35º C> 1.1 x 10^3	35º C> 1.1 x 10^3

Of the five treatments two of them (C1 and C5) showed the presence of *E. coli* both before and after the water treatment with the coagulant obtained from the moringa seed powder (Table 4). The water from the C1 treatment was rainwater, so it was not to contain any kind of microbiological contamination because it was understood that rainwater is water free of contaminants, probably this contamination could have been due to the contact of animals with the water, the pipes for collecting the water could have been dirty of animal waste, the container used for the collection could have been contaminated.

The C5 treatment was weir water, the cistern was supplied by means of a kite car that probably could be contaminated, the cleaning of this type of water transport is fundamental to avoid contamination of the water and consequently of those who use it. The other treatments showed absence of *E. coli*. Drinking water is considered to be that with absence of *E. coli* or fecal coliforms per 100 mL of sample (Brazil, 2017).

Table 4: Analysis result for E. coli before and after water treatment.

E. coli		
Treatments	**Before the treatment**	**After the treatment**
C1	Presence	Presence
C2	Absence	Absence
C3	Absence	Absence
C4	Absence	Absence
C5	Presence	Presence

4. Conclusions

There was a change in chemical parameters after the water treatment. The pH of the water after treatment was closer to neutrality, there was a reduction in alkalinity after treatment and increases in dissolved solids after treatment. Treatments C1 and C5 showed presence of *Escherichia coli*, the other treatments were absent.

Moringa oleifera seed is composed of cationic proteins, which can be applied as an efficient coagulant for the clarification of drinking water human and the use of moringa seeds for the purification of water is an economic alternative.

Unfortunately, the use of the coagulant obtained from moringa seeds used in the treatment of water in the way it was performed in this study showed no changes in microbiological analysis, which requires new studies with different dosages of the coagulant.

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