Effectiveness of Moringa Oleifera Seed as a Biocoagulant for Water Pretreatment, Ilo Province, Moquegua-Peru

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Abstract: The objective of this study is to use Moringa oleifera seed as a biocoagulant to treat turbid water samples during the flood season in the Osmore river in Ilo-Moquegua. The methodology was based on a completely randomized factorial design, using as a response variable the percentage of turbidity removal, the composition of the Moringa oleifera seed was evaluated, the defatting process was carried out, obtaining the flour for the preparation of biocoagulant, the physicochemical parameters were evaluated: temperature, pH and total solids, in addition to the time of action. As a result, the optimum dose was 1.35 ml in flood season (high turbidity) with a sedimentation time of 30 min, thus obtaining a fairly efficient removal in high turbidity, reaching positive values above 95%. Total dissolved solids (TDS) showed a decrease of 45.38% of water in high turbidity. The pH (7.71) and temperature (26.5 °C) did not change, as they were within the standards allowed by national norms. Data that will help the inhabitants and authorities to access and replicate in an easy way and thus treat water with a friendly and sustainable culture with the environment.

1 INTRODUCTION

Currently, water purification processes use different types of reagents such as coagulants, many of these are of artificial origin (Ramirez 2019), some of these reagents for their manufacture can emit many sources of pollution, so it is necessary to study green production biocoagulants (Sandoval and Laines, 2013).

Peru is one of the many countries facing water supply and contamination problems especially in rural or recently inhabited areas as is the case of the Lurin River (Villanueva, 2016) and the human settlement of Santa Rosa in the Algarrobal district of the province of Ilo. For this reason, Peru is no stranger to this problem, as it has many of its regions, provinces, districts and

its regions, provinces, districts, continue to pre-treat water in the different rural areas.

Currently, the fight against global warming and the SDGs is being carried out worldwide to clarify the water in a natural way for this, it is necessary to apply natural polyelectrolytes that act as flocculation aids, allowing to eliminate a significant percentage of turbidity, suspended solids, dissolved organic, dissolved ionic (salts) and microorganisms that can not affect the health of consumers (Delgadillo et al, 2010; Arango and Ortega, 2017).

Microorganisms, heavy metals, turbidity or others can be present in rivers due to natural or anthropogenic activities (Tumbaco and Acebo, 2018; Melo and Turriago, 2012), thus generating that in water treatment plants use inorganic coagulants for their treatment (Sáenz, 2015; Chama, 2017), but in the case of the surrounding areas in rural areas there are few that have a water treatment plant (Broncano and Rosario, 2017), thus risking even a possible

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public health problem and in the environment of the environment. (Coronado, 2018; Vela, 2016).

The province of Ilo has a valley that is considered an agricultural zone, farmers irrigate their crop areas by using the waters of the Osmore River that flows through the valley and finally flows into the sea, the people living in the area use the water to prepare their food and beverages without having gone through a previous pretreatment. One of the main problems of the Osmore River water is the presence of mud or particles (turbidity) and even more so when there is a flood season with heavy rains in summer and autumn in the highlands (Sánchez, 2019). The water arrives very turbid to the Ilo valley with a high percentage of mud, pathogenic microorganisms, making it impossible to consume it (Sanchez, 2019).

This research work seeks to provide a proposed solution for water treatment, using a non-conventional technology for water pretreatment, using the Moringa oleifera seed as a biocoagulant that has protein properties that help improve water quality (Ezhilarasi and Veerasekar, 2014), thus contributing to the inhabitants of the Ilo valley. That is why the present research work aims to use Moringa oleifera seed as a biocoagulant to treat turbid water samples in the Osmore river in Ilo-Moquegua-Peru.

2 METHODOLOGIES

The design used was a completely randomized experimental design (single factor).

Having 4 doses of biocoagulant (1.0 mL, 1.2 mL, 1.3 mL and 1.4 mL) and 1 control for a sedimentation time of 60 min, and 4 doses of biocoagulant (1.2 mL, 1.3 mL, 1.35 mL and 1.4 mL) and 1 control for a sedimentation time of 30 min, making 5 replicates for greater accuracy in the periods of floods.

2.1 Moringa Oleifera Seed Processing

The Moringa oleifera seeds are of natural origin from the province of Ilo, these were taken to the basic chemistry laboratory of the National University of Moquegua - Ilo Branch.

Ten units of Moringa seeds with husk, seed without husk and husk were weighed, the difference in weight was evaluated in percentage to know the raw material for the elaboration of the biocoagulant. Subsequently, it was then dried at room temperature for 1 day (24 hours) for easy use (Sandoval & Laines, 2013). The crushing phase consisted of pulverizing the peeled seeds in a domestic blender (Carrasquero, et al., 2018), with the intention of obtaining moringa powder.

2.2 Analysis of the Properties of Moringa Oleifera

For the determination of the proximate composition of the seeds of Moringa oleifera not segregated, sent 30 gr. of sample to the specialized laboratory of the Universidad Nacional De San Agustín de Arequipa, performing an analysis of moisture (NTP 209.085), fat (NTP 209.093). Protein (AOAC 2057), fiber (NTP Each paper must have at least one keyword. If more than one is specified, please use a comma as a separator. Keywords should appear justified, with a linespace exactly of 11-point, a hanging indent of 2-centimeters, spacing before of 48-point, no spacing after and font size of 9-point. The sentence must end with a period.

2.3 Extraction of Oil and Fats from Seeds of Moringa Oleifera

The solid-liquid extraction or leaching methodology was applied with a solvent called 95% Ethanol (Guamán, & Sánchez, 2018), for this purpose, 80 g of moringa powder were weighed and diluted in a volume of 300 ml of chemically pure 95% ethanol and then homogenized with the help of a magnetic stirrer for a time of 40 min and left to stand for 1 day (24 hours).

2.4 Filtering and Residual Drying of Moringa Oleifera Seeds

After the waiting course of 1 day (24 hours), the filtering process was carried out with a filter paper of 11 μm, thus obtaining the residual cake of the defatted seed with which the research was worked. The solid part (residual cake) Figure 1, was left to dry at room temperature for 1 day, until the ethanol solvent finished volatizing and the Moringa oilseed was defatted.

2.5 Extraction of the Component in Saline Solution

With the intention of making the coagulant more soluble in turbid water. 500 ml of distilled water were prepared and 29.22 g of NaCl were weighed and then homogenized in a magnetic stirrer for a time of 15 min. (Adbul, 2016; Tumbaco & Acebo, 2018).

Figure 1: Moringa oleifera residual cake.

2.6 Obtaining the Biocoagulant based on the Seed of Moringa Oleifera

For the preparation of the biocoagulant as shown in Figure 2, 15 g of defatted Moringa oleifera was added to 500 ml of the saline solution. Then, with the help of the magnetic stirrer, it was mixed for a time of 30 minutes. Finally, the solution was filtered with a filter paper where the biocoagulant was obtained and reserved in a dark glass bottle.

2.7 Concentration of the Biocoagulant of the Seed Moringa Oleifera

Calculations of concentration (w/w) were made, for the time of flooding, doses of 1.2 ml, 1.3 ml, 1.35 ml, 1.4 ml and its control were made with a sedimentation time of 30 min, and doses of 0.8 ml, 1.0 ml, 1.2 ml, 1.4 ml and its control with a time of 60 min, having as fixed speed of 100 rpm. Then, with the range obtained, a new calculation was made to work with more precise data on the concentrations of the doses.

2.8 Evaluation of Physicochemical Parameters in Treated Water

The pH, temperature, and total dissolved solids were evaluated to assess the effect of the biocoagulant on turbidity, using a HACH 2100 AN turbidity meter from the basic chemistry laboratory of the National University of Moquegua. The evaluation of the before and after treatments was carried out with their respective control, marking the difference in the data obtained in percentage of turbidity elimination in the flood and dryness times.

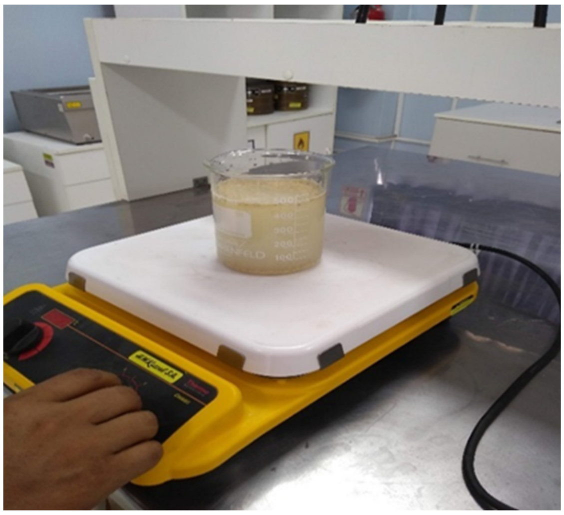

Figure 2: Preparation of Moringa-based biocoagulation.

2.9 Data Analysis

In order to evaluate if significant differences are found between treatments, an analysis of variance will be performed.

3 RESULTS

3.1 Determination of Moringa Oleifera Seed Weight

The results obtained regarding the weight of the seed with shell, seed without shell and shell, it was determined that the weight of the shell is not very significant for the processing of moringa, however, I show that the seed without shell has had a high percentage in weight of 74.4%", which means that it represents a greater or sufficient amount of raw material for the elaboration of the biocoagulant.

3.2 Proximal Composition of Moringa Oleifera Seed

The proximal composition of Moringa Oleifera seed powder without degreaser, obtained results that show a high protein content 38.46% which is important for coagulation, proteins are biopolymers that help the water to have a good flocculation and settle quickly, so the proteins are the main importance for water treatment, in the same way the analysis gives us the data of fat with a percentage of 35.37% that is in the seed important data for extraction in the preparation of the biocoagulant.

3.3 Concentration of The Biocoagulant of Moringa Oleifera Seeds

It was prepared taking into account a volume of 100 ml, a solute mass of 3 g, a solution mass of 99.7 g and a final concentration (%m/m) of 3%.

3.4 Results of Water Treatment at The Time of The Osmore River Flooding

The ideal dose according to the experimental design had a range of 0.8 ml - 1.4 ml for a time of 60 min. The results show that the 1.2 ml dose presents a better turbidity removal, having an average of 85.46 NTU as for the other doses (Table 1).

Table 1: Coagulation percentages in time of flooding in 60 min.

Replica	NTU Initial	Dose				
		Control	0.8 ml (NTU)	1.0 ml (NTU)	1.2 ml (NTU)	1.4 ml (NTU)
R1	863	443	124	116	102	126
R2	739	435	81.8	146	79.6	88.8
R3	739	440	87.5	94.6	84.4	91.3
R4	851	488	86.2	84.4	83.7	92.8
R5	672	376	88.5	126	76.6	96.1
Average		436.4	93.6	113.4	85.46	99

The result of the statistical value of the "F" test is obtained from the division of the mean squares of the treatment and the error (Table 2) with this result we show that there is sufficient statistical evidence to say that the treatments are different and that it effectively demonstrates that the biocoagulant eliminates or reduces the percentage of turbidity in the water in a sedimentation time of 60 min.

With the results it was intended to improve the time to evaluate the difference that can present and how effective the biocoagulant can be, for that the range of 1.2 ml - 1.4 ml was considered performing the same procedure of 5 replicates with a shorter time of 30 min of sedimentation and the agitation speed of 100 rpm in a time of 1 min.

Table 2. ANOVA analysis of variance of coagulation in time of flooding in time of 60 min.

Source of variation	Sum of Square	Degrees of freedom	Square Middle	F
Treatment	460497.2784	4	115124.32	204.0055
Error	11286.392	20	564.3196	
Total	471783.6704	24		

Table 3: Coagulation percentages in time of flooding in 30 min.

Replica	NTU Initial	Dose				
		Control	1.2 ml (NTU)	1.3 ml (NTU)	1.35 ml (NTU)	1.4 ml (NTU)
R1	2437	1438	182	144	146	123
R2	4543	2861	128	128	116	130
R3	4543	3006	132	121	114	203
R4	4861	3025	121	118	102	120
R5	4861	3084	116	153	107	178
Average		2682.8	135.8	132.8	**117**	150.8

Table 3 shows that the 1.35 ml dose shows better turbidity elimination and less time compared to the other tests carried out; at the same time, it does not show much difference in relation to the previous analysis with a time of 60 min, demonstrating that the biocoagulant helps to improve water clarification. To demonstrate its effect, ANOVA was carried out, concluding that there is sufficient statistical evidence to say that the treatments are different and that it was indeed demonstrated that the biocoagulant eliminates or reduces the percentage of turbidity in the water in a sedimentation time of 30 min. (Table 4)

Having the results of the sedimentation times (30 and 60 min), as well as the average turbidity removal in the water, the final result was taken as the 1.35 ml dose since it presents less time and the difference in turbidity is less, since for the studies and the use of coagulant in a water pretreatment, the minimum removal is required and in less time.

Table 4: Analysis of variance ANOVA of coagulation in time of flooding in time of 30 min.

Source of variation	Sum of Square	Degrees of freedom	Square Middle	F
Treatment	25986366.16	4	6496591.54	65.81049
Error	1974333.2	20	98716.66	
Total	27960699.36	24		

3.5 Analysis of Temperature, pH and Total Dissolved Solids

A pH and temperature analysis were performed before and after pretreatment of the Osmore River water sample in 100 ml beakers with a volume of water to be treated of 80 ml in order to evaluate whether the biocoagulant generates an alteration in the physicochemical parameters, which had the following results observed in Table 5, showing that it does not vary significantly in the final pH.

The final pH and temperature is below the initial one, which, in turn, does not alter the application of the biocoagulant that seeks to improve water clarification. The 1.35 mL dose (pH 7.9 and 27 °C), it was observed that in samples 1 to 5 of water in the flood season, it was presented with an average of 26.7 °C in comparison with the untreated sample that presents 26.5 °C, meaning that there was no alteration or modification as well as the pH parameter that had an average of 7.71, and is within the range standardized by national norms.

Table 5: Influence of the optimal dose (1.35 ml) on pH and temperature parameters.

Sample	Dose	Initial pH	Initial temperature	Types of sedimentation	Final pH	Final temperature
M 1	1.35 ml	7.9	27		7.75	26.7
M 2	1.35 ml	7.9	27	30 min.	7.70.	26.7
M 3	1.35 ml	7.9	27		7.67	26.6
M 4	1.35 ml	7.9	27		7.74	26.9
M 5	1.35 ml	7.9	27		7.71	26.9
M 6	0 ml	7.9	27		7.76	26.5

3.6 Results of Total Dissolved Solids

After three repetitions, it can be observed that in Figure 3, sample 6, which is not treated, shows a high load of total dissolved solids in the three tests, unlike samples 1 to 5, which shows the influence of the dose of 1.35 ml in the treated vessels, which means that it shows a reduction of total dissolved solids in the treated water in times of flooding, and that total dissolved solids are also a problem for the pretreatment of water and for health.

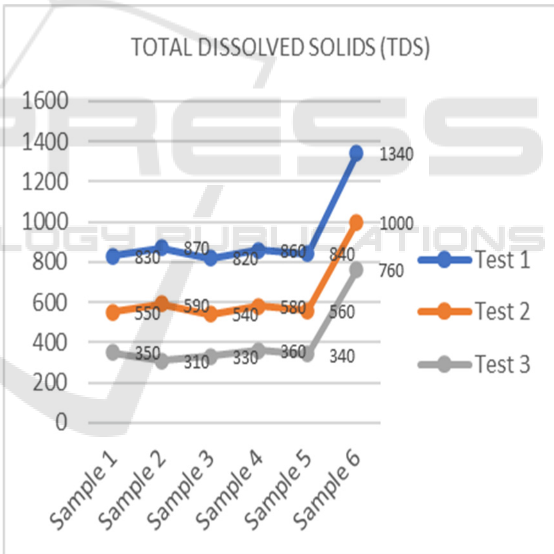

Figure 3: Influence of biocoagulant on total dissolved solids over time of flooding.

4 DISCUSSIONS

This research work studied the adequate concentration for the flood season in which a very high turbidity was demonstrated during the tests performed, which showed a great capacity to eliminate turbidity by treatment with moringa when there is presence of high turbidity load demonstrating a great difference in the adequate concentration for the dry season, which is efficient the higher the turbidity the greater the effect of the biocoagulant seed Moringa oleifera, this allows its use to be recommended when there is higher turbidity in the Osmore River. (Sanchez, 2019).

In the testing process, the optimal time in terms of sedimentation of the treated water is much shorter the time when there is presence of high turbidity than in low turbidity, which makes the effectiveness of the biocoagulant act instantaneously to the elimination of turbidity, and can be used when it occurs in times of flood (Tumbaco and Acebo, 2018).

The application and direct use of the Moringa oleifera seed biocoagulant, does not produce alteration or change its initial values nor does it represent an additional cost to correct the pH and temperature of the treated water compared to chemical polymers that, if it tends to alter, on the other hand, reduces a percentage in terms of total dissolved solids (TDS) compared to other chemical polymers such as aluminum sulfate used commercially. for pretreatment in water, which generates alkalinity in the treated water so it is necessary to add alkalis such as lime, which is advisable to use as a natural coagulant Moringa oleifera seed before the ability to remove turbidity (Vela, 2016).

However, it would be ideal to perform some more analyses such as coliform bacteria, and some chemical tests such as nitrates and nitrites, Total Organic Carbon (TOC), to obtain data that would help provide a good assessment of water quality, and determine if there is a decrease or elimination of these parameters by applying the Moringa oleifera seed biocoagulant.

5 CONCLUSIONS

It was determined that the concentration of the biocoagulant for the removal of high turbidity is an optimal dose of 1.35 ml in a sedimentation time of 30 min, the effectiveness of the biocoagulant from the Moringa oleifera seed acts much better when there is a greater amount of turbidity, that is, in times of flooding. It was demonstrated that the preparation and application of the biocoagulant based on Moringa oleifera seeds has a turbidity removal in flood season (high turbidity) of 95.97 %. In other parameters, it has not generated any alteration in the pH since it remained relatively stable with an average of 7.71 during the flood season; likewise, its temperature did not change since its average was 26.5 °C in high turbidity water, data that are standardized and allowed for pretreatment. As for total dissolved solids (TDS), the application of the optimum doses showed a decrease of 45.38% during the flood season.

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REFERENCES

Association of Official Agricultural Chemists, AOAC 2057.

Association of Official Agricultural Chemists, AOAC 31043.

Association of Official Agricultural Chemists, AOAC 2173.

Arango Mesa, S., & Ortega González, W. P. (2017). Evaluation of Moringa oleifera seed extract as a coagulant agent in the treatment of wastewater of a textile industry [Undergraduate Thesis, EAFIT University]. Institutional repository. Obtained from http://hdl.handle.net/10784/12230.

Broncano Castillo, L. E., & Rosario Cacha, N. P. (2017). Efficiency of the shell of Tropaeolum Tuberosum and solanum Tuberosum as a coagulant for the removal of turbidity, color and dissolved solids, in the Llullán River, province of Caraz, Ancash [Tesis de licenciatu, Universidad Nacional Santiago Antúnez de Ma. Institutional repository. Obtained from http://repositorio.unasam.edu.pe/handle/UNASAM/1976

Chama, J. (2017). Evaluation of the coagulant power of potato starch (solanum tuberosum) var. unique and aluminum polychloride for the elimination of turbidity at the entrance of the waters to the samegua treatment plant, Moquegua 2016. Moquegua: José Carlos Mariátegui University.

Coronado Valdivia, Fiorella Milagros. (2018). Efficiency of Agave and Aloe vera in the elimination of organic matter from the waters of the Lurín River in the AA.

S.A.R. Julio César Tello [Bachelor's Thesis, César Vallejo University]. Institutional repository. Obtained from https://hdl.handle.net/20.500.12692/36217

Delgadillo, O., Camacho, A., Peréz, L., & Andrade, M. (2010). Wastewater treatment by artificial wetlands. Cochabamba: Universidad Mayor San Simón.

Ezhilarasi, M., & Veerasekar, N. (2014). Water treatment with Moringa oleifera seeds and kernals in stream water. International Journal of Research in Engineering and Technology, 495-505.

Ghebremichael, K. (2004). Moringa seed and pumice as alternative natural materials for drinking water treatment [Doctoral thesis, Mark och vatten]. institutional repository. Obtained from http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-85

Guamán Santillán, C. F., & Sánchez Sancan, T. J. (2018). Effectiveness of moringa oleifera seed coagulant solutions in urban wastewater treatment [Undergraduate Thesis, University of Guayaquil]. Institutional Repository. Obtained from http://repositorio.ug.edu.ec/handle/redug/33218

Melo Vargas, G. R., & Turriago Ríos, F. A. (2012). Evaluation of the efficiency of the use of Moringa oleifera seeds as an alternative for bioremediation in the purification of surface waters of the duck tail tube located in the rural sector of the municipality of Acacias [Tesis de licenciatu,. Institutional repository. Obtained from https://repository.unad.edu.co/handle/10596/1428.

Peruvian Technical Standard NTP 209.085

Peruvian Technical Standard NTP 209.093

Peruvian Technical Standard NTP 209.074

Ramírez Ramírez, L. I. (2019). Evaluation of tamarind seeds (Tamarindus indica) as a coagulant to reduce the pollutant load in water treatment, in relation to a commercial coagulant [Bachelor's thesis, Salesian Polytechnic University]. Institutional repository. Obtained from https://dspace.ups.edu.ec/handle/123456789/17855

repository, Lima. Obtained from https://hdl.handle.net/20.500.12692/10877

Vela Arévalo, c. T. (2016). Reduction of turbidity using natural coagulant Moringa oleifera in waters obtained from the Alto Chicama River, Puente Ingón, Trujillo [Undergraduate thesis, César Vallejo University]. Institutional repository. Obtained from https://hdl.handle.net/20.500.12692/7597

Villanueva Vargas, J. F. (2016). The governance of water resources in the Lurín river basin within the framework of the creation of the Water Resources Council of the Chillón basin, Rímac, Lurín [Master's Thesis. Pontifical Catholic University of Peru]. Institutional Repository. Obtained from http://hdl.handle.net/20.500.12404/7159

Walpole, R., Myers, R., Myers, S., & Ye, K. (2012). Probability and statistics for engineering and science. Pearson Education of Mexico. doi: ISBN: 978-607- 32-1417-9.

Sáenz Tahua, W. S. (2015). Use of the natural seed Moringa Oleífera as a coagulation aid in the water purification plant of the city of Caraz province of Huaylas Ancash [Bachelor Thesis, National University Santiago Antúnez de Mayolo]. Institutional repository. Obtained from http://repositorio.unasam.edu.pe/handle/UNASAM/1692

Sánchez Valencia, Rodolfo Rafael, (2019). Heavy metal levels (pb, al and sr) in the avenue and dry season in the Osmore River, region moqueguahttp://repositorio.unsa.edu.pe/bitstream/handle/UNSA/8804/UPMsavarr.pdf?sequence=1&isAllowed=y

Sandoval Arreola, M.M., & Laines Canepa, J. R. (2013). Moringa oleifera is an alternative to replace metal coagulants in surface water treatment. Engineering, 13(2), 93-101.

Tumbaco Talledo, D.M., & Acebo Mite, k.M. (2018). Efficiency of the biocoagulant based on Moringa oleifera seed for water treatment application using the Guayas River as a source of capture [Bachelor's Thesis, University of Guayaquil]. Institutional Repository. Obtained from http://repositorio.ug.edu.ec/handle/redug/27909

Urquía Collantes, K. (2017). Efficiency of Ficus-Indica Opuntia against Moringa Oleifera, in the treatment of waters of the Huaycoloro River, SJL-2017 [Bachelor's thesis, César Vallejo University]. Institutional