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RESEARCH ARTICLE

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USE OF *TAMARINDUS INDICA* SEED AS AN ORGANIC COAGULANT IN THE TREATMENT OF WATER FOR HUMAN CONSUMPTION

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ABSTRACT

The coagulant used most frequently in the purifying process is aluminium sulphate. However, it has been noted that its use leaves residual aluminium in water intended for human consumption; in addition, this mineral has been found in the brains of those suffering from Alzheimer's disease, implying a connection between the two. Natural coagulants derived from plant or animal species are currently being studied as an alternative. The efficiency of tamarind (Tamarindus indica) seeds in extremely turbid water was assessed in this study. The tests were conducted in a laboratory setting using tap water as dilution water for the preparation of samples with turbidity values of 100, 200, 300, and 350 NTU. Various doses of Tamarindus indica were used, ranging from 61.83 ppm (for 100 and 200 NTU) to 74.19 ppm (for 300 NTU), with the optimal doses being 86.56 ppm (for turbidity values of 111.3 NTU) and (350 NTU). The results demonstrated the coagulant's effectiveness, with elimination percentages for the turbidity after the treatment ranging from 72.45% to 89.09% for the optimal doses, before to filtering, and from 98.78% to 99.71%, following filtering. The colour was located between 30 and 40 UC after filtering and between 120 and 266 UC prior to filtering. There were not many differences in the pH and alkalinity. These findings support the use of *Tamarindus indica* as a reliable coagulant in water purification, replacing chemicals like aluminium sulphate.

Keywords: *Tamarindus indica* seed, high turbidity waters, coagulant, aluminium sulphate.

INTRODUCTION

One of the elements required to maintain life and a resource that is becoming more and more valuable is water. Water must undergo a number of essential treatments, such as clarifying, disinfection, chemical conditioning, and organoleptic conditioning, in order to be fit for human consumption. Coagulation-flocculation is a technique for clarifying water that involves creating minute masses of particles in the water that have a specific weight larger than the water itself. The particles settle as a result, and the water then has qualities that are safe for human consumption (Porras, 2001). Currently, aluminium sulphate, $Al_2(SO4)_3$, which has been demonstrated to be unhealthy when consumed in high amounts, is utilised as a coagulant in India. The efficiency of plant species as coagulants that enable the full or partial replacement of aluminium sulphate must therefore be assessed.

Powdered seeds of *Moringa oleifera* (Mendoza et al., 2000), *Stenocereus griseus* (Fuentes et al., 2011), *Hylocereus lemairei* (Mendoza et al., 2008), *Aloe vera* (Daz and Daz, 2007), and the species Tamarindus indica have all been used to remove colour from leftover water from textile industries and are natural coagulants of vegetable origin (Anuradhha and Malvika, 2004). This study aimed to assess the coagulant properties of tamarind (Tamarindus indica) seed extract in extremely turbid water. Aesthetic, physicochemical, and microbiological requirements for drinking water include being free of observable turbidity, colour, flavour, and taste, as well as being free of pathogenic bacteria and having a reasonable temperature. Natural waters are nearly never of high enough quality to be used for industrial purposes or for human consumption (Cabral JP, 210).

Coagulation and flocculation are two physicochemical processes that are considered in the processing of raw water. In order to comply with the requirements of current health regulations, a coagulant, also known as a chemical destabilizer of particles, is added to the volume of water to be treated in order to agglomerate the suspended solids together and form larger and heavier particles, known as flocs, which will settle.

Chemical coagulating agents, including salts of iron and aluminium, are among the most popular. Due to its excellent effectiveness in eliminating turbidity and colour, which in turn permits a reduction of pathogenic bacteria, aluminium sulphate is the most commonly utilised (Md. Asrafuzzaman, 2011).

The use of this chemical coagulant has been reported to produce residual aluminium in drinking water. Additionally, the presence of this mineral in the brain has been detected in individuals with Alzheimer's disease, implying a relationship between the two. However, it has been demonstrated that the substances that result from this chemical coagulant can be negatively assimilated by humans in the long term. Additionally, its effects have been linked to a number of cancer types and bone illnesses that affect the nervous system (Hassan, et al 2009).

As an alternative, developing nations have modified a number of age-old techniques to get rid of turbidity in residential water. The use of natural plant extracts for the purification of raw water is the most researched of them (Mehdinejad, 2009). Because natural coagulants are often ingested, their presence in effluent poses little hazardous risk to people. Additionally, they produce five times less sludge than chemical coagulants when employed in standard treatment methods, and the sludge they do produce is extremely biodegradable and nutritious (WHO, 2006).

According to Ndabigengesere, et al (1995), the majority of naturally occurring coagulants are obtained from extracts of seeds, leaves, bark or sap, roots, and fruits that are taken from trees and plants. The use of coagulants made from dried seeds of plants like *Moringa oleifera, Leucaena leucocephala, Albizia lebbeck, Phaseolus vulgaris, Prunus persica, Mangifera indica L., and Tamarindous indica* for the clarification of raw water has been demonstrated by a number of authors to be a viable alternative for the clarification of raw water and to reduce the potential harm that the aluminium residual could do to human health, the tamarind seed is mostly made up of water (11.3%), protein (13.3%), and carbs (57.1%). According to Gurdián and Coto (2011), glycine and leucine make up the majority of the protein fraction, and the first two are what cause coagulation. Tamarind seeds include a variety of nutrients. The seeds are generally a rich source of carbs, crude fibre, and protein. High mineral concentrations, particularly for potassium and magnesium. The seed coat is high in fibre (20%) and tannins (20%), while the seeds and kernels are high in protein (13-20%). The study's goal was to assess the tamarind (*Tamarindus indica*) seeds' capacity as a coagulant in the treatment of synthetic water with low, medium, and high turbidity levels.

METHODOLOGY

Procedure for obtaining the coagulant Tamarindus indica

2.1. Tamarindus indica seed processing

The tamarind seeds were collected from the waste generated in the process of making tamarind juice from various sites in the city of Vijayawada, Andhra Pradesh, India. The seeds were submerged in abundant water to separate the adhering pulp remains and facilitate the removal of the testa or seminal cover that surrounds the cotyledon (Carrasquero et al., 2015). Next, the cotyledons obtained were dried at a temperature of 25±2°C for 24 hours, and then ground using an electric mill (Oster brand), until white flour was obtained, which was stored in amber-colored jars for later processing. use.

Obtaining synthetic water

To obtain the synthetic water, tap water from the Environmental Research Laboratory of the Eastern Coast of the Lake Nucleus (LIANCOL) was taken. To obtain the initial turbidity required in this study (100, 200, 300 and 350 NTU), commercial clay was added to the water. For the preparation of the clay, 26 g of it were taken, placed in a beaker and water was added to complete 100 ml, then the mixture was stirred for 5 minutes with the purpose of dissolving the clay. bulk and left to hydrate for 24 hours at room temperature. The supernatant clayey mixture was added to tap water to obtain the desired initial turbidity values. The water samples conditioned according to the turbidity values under study also required a pH adjustment (approximately 4.00 units), since various preliminary tests allowed establishing that the greatest amount of flocs are formed at pH@ 4.00.

Laboratory tests

Once the natural coagulant was obtained, the tests related to the physicochemical parameters (turbidity, color, pH and alkalinity) were carried out for the water samples under study. Before and after adding the coagulant (before and after the filtration process).

Jar Test

For the preliminary and general test, a digital JLTG Leaching test jug unit was used, which allows the phases of the purification process to be simulated in the laboratory (coagulation, flocculation and sedimentation).

To carry out the jar tests, the glasses were filled with 1 L of water at high turbidity values. The equipment was turned on at 100 rpm for 1 minute of agitation, adding the different doses of coagulant. After the minute of rapid stirring, slow stirring was carried out, which is done at 30 rpm for 20 minutes, and finally stirring was suppressed to simulate the sedimentation phase for 30 minutes.

Measurement of physicochemical parameters

For the determination of turbidity, the HF scientific, Inc. Micro 100 Turbidimeter equipment was used. Their calibration was performed using formazin solutions. For pH measurement, an Orion 3 Star potentiometer was used, which was calibrated with buffer solutions of pH 10, 7.00 and 4.01. For the determination of color, the Orbeco-Hellige equipment was used. The measurement of the alkalinity parameter was carried out from the titration of the samples with sulfuric acid (H2SO4), at 0.02N with the methyl orange indicator.

ANALYSIS AND DISCUSSION OF RESULTS

Tap water characterization

The water samples from the tap were characterized in terms of the physicochemical parameters turbidity, color, pH and alkalinity, initially obtaining the values presented in Table 1.

Table 1. Initial values of the physicochemical parameters of tap water.

Turbidity (NTU)	Color (UC)	pH	Alkalinity (mg $CaCO_3$/L)
9	40	5.61	30
5.05	30	6.01	26
7.05	40	7.3	28

As can be seen, the values present in tap water mostly do not comply with the parameters established by the standards (Official Gazette, 1998), but these values served as a starting point for the preparation of synthetic waters according to the requirements of the study 100, 200, 250, 300 and 350 NTU.

Evaluation of the optimum pH for turgidities of 100 and 350 NTU

The study carried out with Tamarindus indica seed extract showed that at pH values equal to and greater than 7.00 units it did not form flocs, for which reason its efficiency was evaluated at low pH values, achieving a greater removal at pH equal to 4.00 units. The results can be seen in Figures 1 and 2. Based on these results, the various initial turbidity values were evaluated at a pH experimentally adjusted to 4 units. Specifically, at an initial turbidity of 100 NTU with pH values adjusted to 7 and 9 units, no decrease in the turbidity parameter was observed after treatment with the coagulant obtained from Tamarindus indica; while, at a pH of 4 units, the turbidity decreased to approximately 29.03 NTU, observing spherical and very numerous flocs (Figure 1).

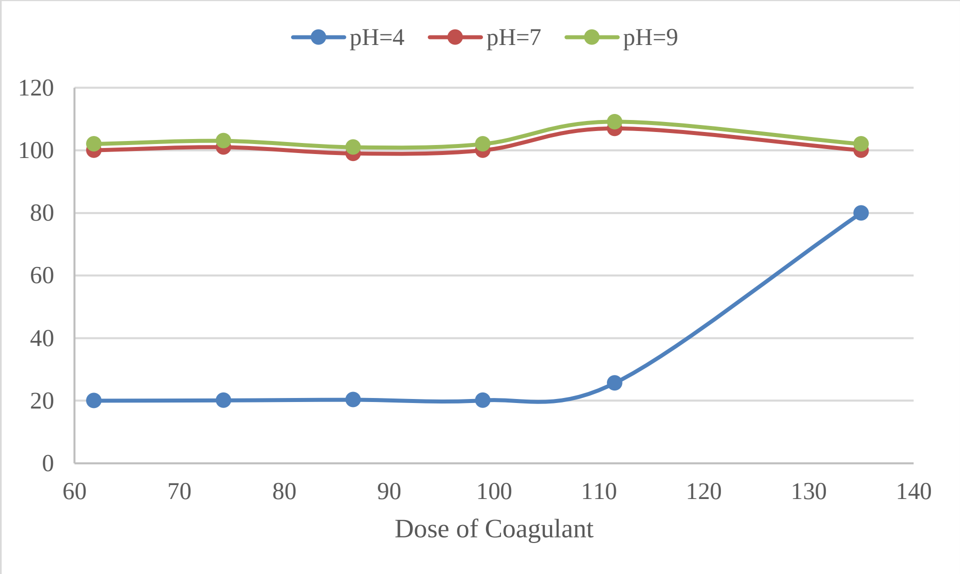

Figure 1:. Removal of turbidity (initial 100 NTU) by addition of coagulant Tamarindus indica at pH=4.00, pH= 7.00 and pH=9.00 for samples.

When evaluating water with an initial turbidity of 350 NTU, treated with Tamarindus indica by applying different pH levels, it is observed in a similar way to the previous case, that at pH values adjusted to 7 and 9 units no flocs were formed and turbidity alone - mind presents a slight decrease; unlike the sample adjusted to pH of 4 units with which an average of 28.51 NTU is observed, considerably decreasing said parameter (Figure 3).

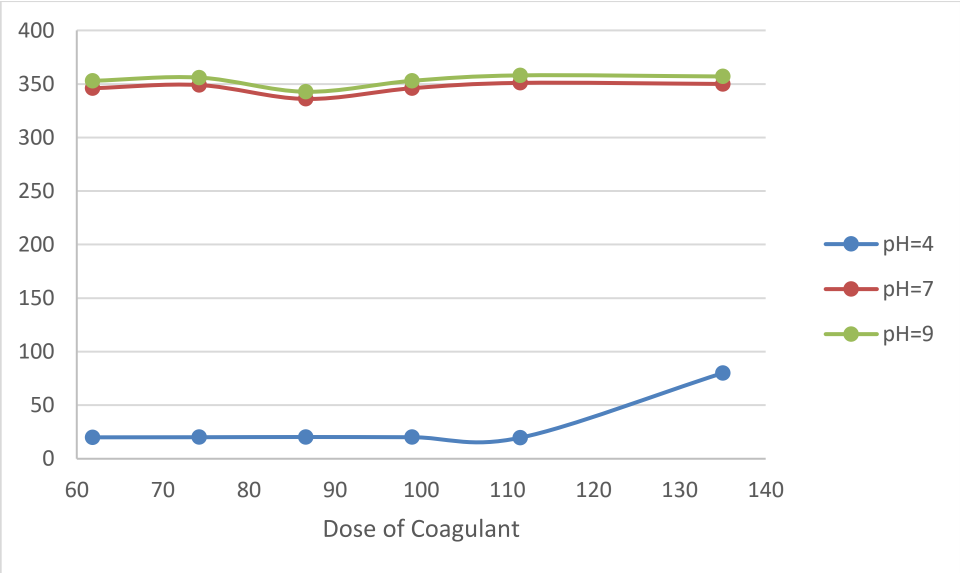

Figure 2: Turbidity removal by adding the Tamarindus indica coagulant at pH=4.00, pH=7.00 and pH=9.00 for samples with an initial turbidity of 350 NTU.

Synthetic water characterization

Since the turbidity values of the raw water were below the initial values required for this study, where the pH should be 4 units, synthetic water was prepared by adding clay and adjusting the pH with acetic acid until the desired values. The results of the physicochemical parameters of the synthetic water used to carry out the coagulation-flocculation process are presented in Table 2.

Table 2. Average values of the physicochemical parameters of the synthetic water

Turbidity (NTU)	Color (UC)	pH	Alkalinity (mg CaCO3/L)
100	240	4	12
200	300	4.02	18
300	480	4.02	30
350	480	4.04	20

Turbidity removal

As can be seen in Table 3, for turbidities of 100 and 200 NTU, a single optimal dose was obtained (61.83 ppm) and the decanted turbidity increased as the initial turbidity increased. This coincides with what was reported by Mendoza et al. (2000), who also obtained a single optimum dose (20 mg/L) when using *Moringa oleifera* as coagulant. However, once the treatment for this initial turbidity has been completed, it can be observed that the coagulant removed a little more than 99% of the turbidity present in the water, evidencing the high coagulant power of the tamarind seeds at these turbidity values. Likewise, for an initial turbidity of 300 NTU, it is evident how the optimal dose of the coagulant increased considerably; however, a 99.71% removal is observed once the samples are filtered.

Evaluation of the pH parameter

The pH parameter presented little variation after treatment. This was maintained between 4.07 and 4.26 units before filtering, and between 4.14 and 4.42 units after filtration (Table 4), demonstrating that the pH remained very acid, leaving outside the ranges established by the Official Gazette (1998).

Evaluation of the color parameter

The values are well above what is stipulated by the Water Quality Standards. The decrease in color can be seen up to a range between 30 and 40 UC after the filtration process, with color removal percentages ranging between 67.47% and 99.60% (Table 5). This parameter does not meet the requirements of the regulations to be within the standards (15 UC).

The color values presented in this report are similar to those reported by González et al. (2009), according to which there was a removal of color, had between 95.63 and 100%. It should be noted that in this investigation the initial color values were very high and despite the fact that the removal percentage was greater than 90%. This parameter did not meet the values established by ISI and WHO(1998).

Alkalinity parameter evaluation

The alkalinity values before and after treatment with Tamarindus indica fluctuated between 17.33 and 20.66 mg $CaCO_3$/L before filtering and between 16.00 and 18.66 mg $CaCO_3$/L after filtering, observing that the coagulant did not alter this parameter and it remained within the permissible limit.

Table 3. Initial turbidity values, optimal dose and removal percentages obtained during water treatment with Tamarindus indica

Initial Turbidity (NTU)	Optimal dose (ppm)	Turbidity before filtering (NTU)	Removal before filtering (%)	Turbidity after filtering (NTU)	Removal after filtering (%)
100	61.83	20.33	73.45	0.67	99.1
200	61.83	24.06	81.68	1.2	99.05
300	86.56	26.66	87.24	0.61	99.71
350	74.19	26.1	89.09	1.04	99.56

Table 4. pH values before and after filtering for the optimal doses

Initial Turbidity (NTU)	Optimal dose (ppm)	Standard pH before filtering	Standard pH after filter	pH before filtering	pH after filtering
100	61.83	4.06	4.11	4.07	4.14
200	61.83	4.14	4.19	4.2	4.24
250	61.83	4.11	4.16	4.26	4.24
300	86.56	4.15	4.13	4.14	4.15
350	74.19	4.44	4.42	4.45	4.42

Table 5. Color removal values before and after filtering for the optimal doses

Initial Turbidity (NTU)	Optimal dose (ppm)	Pattern color before filtering	Pattern Color After Filtering (UC)	Color of AF samples (UC)	% Removal	Color of samples DF (UC)	% Removal
100	61.83	240	43	120	50	30	87.52
200	61.83	300	50	240	20	40	67.47
250	61.83	480	40	240	50	40	91.67
300	86.56	480	50	240	62.5	40	91.67
350	74.19	480	50	266	44.44	33	99.6

The Drinking Water Quality Standards of India and USEPA, establishes a maximum of 200 mg $CaCO_3$/L for the quality of water for human consumption. Considering these limits, the alkalinity in this investigation was low. The results obtained in this study can be compared with those reported by Mendoza et al. (2000), where the efficiency of *Moringa oleífera* and its effect on alkalinity were evaluated, in which a minimal variation was observed.

CONCLUSIONS

The results showed that Tamarindus indica can be considered as an alternative among the natural coagulants for water purification with turbidity values between 100 and 350 NTU, since the percentages of turbidity removal ranged between 72.45% and 89.09% before of the filtration process and after filtering them, between 98.78% and 99.71%.

References

[1]. Ndabigengesere, K. S. Narasiah, and B. G. Talbot, “Active agents and mechanism of coagulation of turbid waters using Moringa oleifera,” Water Research, vol. 29, no. 2, pp. 703–710, 1995.

[2]. Ajayi, I., Oderinde, R., Kajogbola, D., Uponi, J (2006). Oil content and fatty acid composition of some underutili- zed legumes from Nigeria. Food Chemistry, 99, 115 – 120.

[3]. Anuradhha, M and Malvika, B (2004) The flocculation performance of Tamarind us mucilage in relation to the elimination of direct water-insoluble dyes. Department of Chemistry, University, Institute of Engineering and Technology, CSJM; University, Kumpur 208024: India.

[4]. Cabral JP. Water microbiology. Bacterial pathogens and water. Int J Environ Res Public Health. 2010 Oct;7(10):3657-703. doi: 10.3390/ijerph7103657. Epub 2010 Oct 15

[5]. Diaz, A. & Diaz, D (2007). Purification of the waters usefuli- Zando the Aloe vera how coagulant natural. Work Special of Degree Program of Engineering. Nucleus Eastern Coast of the Lake. Universidad del Zulia, Mara-caibo, Venezuela, 55 pp.

[6]. El-Siddig, K., Gunasena, H., Prasa, B., Pushpakumara, D., Ramana, K., Vijayanand. P., Williams, J (2006). Ta- marindus indica L. Fruits for the future 1. Southamp- ton Centre for Underutilized Crops, Southampton, UK, 188 p.

[7]. Fuentes, L., Mendoza, I., López, A., Castro, M., Urdaneta, C (2011). Effectiveness a coagulant extracted from Steno-cereus griseus (Haw.) Buxb. in the purification of water. Technical Journal of the Faculty of Engineering University of Zulia. 34 (1): 48-56.

[8]. González, Y., Marcano, N., Mendoza, I. and Fuentes, L. (2009). Effectiveness of a suspension of Opuntia ficus-indica (L) Mill (Cactaceae) in the clarification of synthetic waters with high turbidity. Scientific impact. 4(2): 361-374.

[9]. Gurdian , R. , Coto , J. , & Salgado , V. (2009). Natural and traditional coagulants for wastewater purification. Heredia, Costa Rica. Spanish Academic.

[10]. Gurdián, R. & Coto, J. (2011). Preliminary study of the use of tamarind seed (Tamarindus indica) in the coagulation-flocculation of wastewater. Technology in Motion, 24(2),18-26.

[11]. Hassan, M. A. A., T. P. Li, and Z. Z. Noor, “Coagulation and flocculation treatment of wastewater in textile industry using chitosan,” Journal of Chemical and Natural Resources Engineering, vol. 4, no. 1, pp. 43–53, 2009.

[12]. Ishola M.; Agbaji E.; Agbaji A (1990). A Chemical Study of Tamarindus indica

(Tsamiya) Fruits Grown in Nigeria. Journal of the Science of Food and Agriculture, 51, 141-143.

[13]. Md. Asrafuzzaman, A. N. M. Fakhruddin, Md. Alamgir Hossain, "Reduction of Turbidity of Water Using Locally Available Natural Coagulants", International Scholarly Research Notices, vol. 2011, Article ID 632189, 6 pages, 2011. https://doi.org/10.5402/2011/632189

[14]. Mehdinejad, M. H., B. Bina, M. Nikaeen, and H. M. Attar, "Effectiveness of chitosan as natural coagulant aid in removal of turbidity and bacteria from turbid waters," Journal of Food, Agriculture and Environment, vol. 7, no. 3-4, pp. 845–850, 2009.

[15]. Mendoza, I., Fernández, N., Ettiene, G. and Diaz, A (2000). Use of Moringa Oleifera as a coagulant in the purification of waters Science Magazine, Vol. 8, No 2.

[16]. Mendoza, I., Fuentes, L., Caldera, Y., Perdomo, F., Suárez, A., Mosquera and Arismendi H (2008). "Efficiency of Hylocereus lemairei how coagulant-flocculant in aguaspara consumption human". Impact Scientist. Review Arbitrated Venezuelan of the Nucleus LIGHT- Cols Eastern Lake. 3(1): 53-69.

[17]. Porras, M (2001). Water supply and facilities in residential buildings . Editorial FEU- NET. San Cristobal- Venezuela. 294p.

[18]. WHO, Guideline for drinking-water quality (electronic resources): incorporating first addendum. Vol. 1, Recommendations, 3rd edition, 2006.