

Application of natural coagulants to reduce the turbidity present in water from drainage channels that feed the Endhó dam, Hidalgo, Mexico

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Nowadays, Mezquital Valley is one of the largest wastewaters irrigated agricultural regions in the world. Due to the semiarid climate and low rain precipitation, for more than 150 years, enormous volumes (50 m³/s) of wastewater generated in the Metropolitan Zone of Valley of Mexico (21,804,515 inhabitants), are discharged without treatment on drainage channels and networks that supply the main irrigation districts of the state of Hidalgo, which flow into the Endhó dam. However, the route continues for more than 500 km, from its source to the Gulf of Mexico, generating important water security problems, as well as serious damage to the environment and the health of the socio-ecological systems of the region (Chamizo-Checa et al., 2020; García-Salas, 2020). To counteract the socio-environmental challenges originated using untreated wastewater, as well as promote sustainable agricultural production, the Federal Government completed the construction of a wastewater treatment plant in Atotonilco de Tula, right at the entrance of the Mezquital Valley. Despite its maximum capacity (35 m³/s), today the plant treats less than 50% of the water generated in the Valley of Mexico (Figure 1).

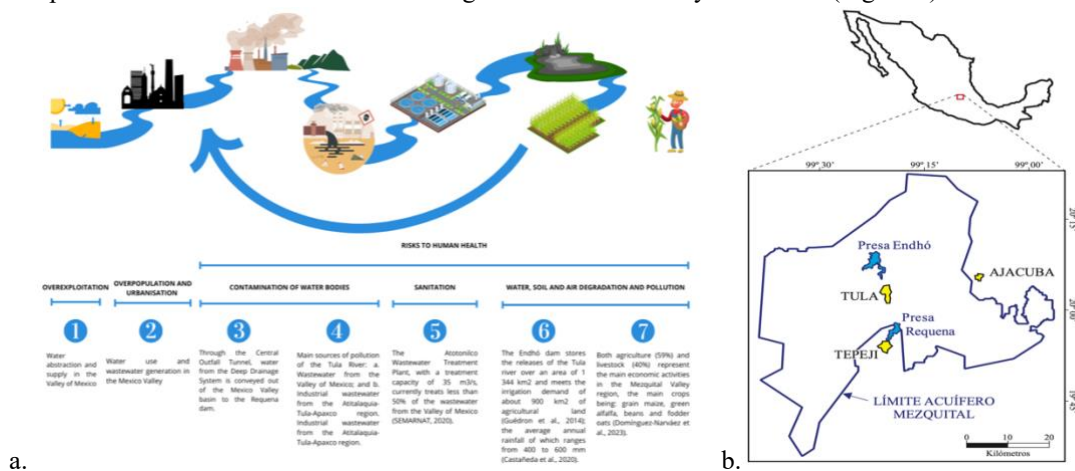


Figure 1. a. Socio-environmental problems surrounding the Endhó Dam socio-ecological system; b. Location of area of study.

Water reuse applications have been accepting solutions with substantial challenges regarding the selection of water treatment technologies. One of the wastewater treatment techniques that stands out for its simplicity, profitability, effectiveness, and low energy demand is coagulation-flocculation; However, coagulation with synthetic or commercial chemicals, today, is a cause for concern since they generate large quantities of sludge, considered hazardous waste. In this sense, an alternative, ecological and sustainable approach, such as natural coagulants, attracts attention since they are biodegradable, less toxic, generate less sludge, do not negatively affect human health, and do not induce changes in physical properties. chemicals of the treated water (Balbinoti et al., 2023). Therefore, the objective of the study was to evaluate the application of natural coagulants to reduce the turbidity present in wastewater that feeds the Endhó dam, Hidalgo, Mexico, at a laboratory level. Part of the methodology was to establish a concentration range (10 mg/L to 60 mg/L) for two natural coagulants (*Moringa oleifera* and *Opuntia ficus indica*) and two commercial coagulants (aluminum sulfate and ferric chloride), with the

intention of obtain maximum turbidity removal in the samples collected from wastewater during the rainy season in the month of August. The sampling point (20°07'41.3" N and 99°21'29.1" W) is in one of the drainage channels that feeds the Endhó dam in the municipality of Santa Ana Ahuehupan, Mezquital Valley. To carry out the jar tests, a statistical design of 4x6 factorial experiments in randomized block design was established ($Y_{ijk} = \mu + \beta_i + \alpha_j + \tau_k + \alpha\tau_{jk} + \varepsilon_{ijk}$), with the aim of identifying the optimal dose of each treatment, it is worth mentioning that the experiments were carried out at room temperature without adjusting the initial pH of the wastewater, as well as specifying that the natural coagulants were extracted from organic residues of moringa and mucilage, obtaining a value-added by-product. Finally, ecotoxicity tests were carried out on the sludge generated during the coagulation-flocculation process of the four coagulants analyzed, using lettuce seeds (*Lactuca sativa L*) to obtain a germination index per treatment.

Statistical analysis was performed with the programming language R 4.3. 0, where the ANOVA showed that there is no interaction between the coagulant dose and the type of coagulant, indicating that each coagulant acts differently on the wastewater of the canals that feed the Endhó dam; For example, ferric chloride obtained the highest percentage of turbidity removal (88%) with the highest dose of coagulant, unlike moringa, which obtained a maximum removal percentage of 69%, but its variability is not significant between the different doses used, i.e. moringa can achieve acceptable levels of removal (15 NTU) with low doses of coagulants without altering the pH of the wastewater. On the other hand, aluminium sulphate shows a tendency to improve its efficiency with higher doses than those evaluated, as well as a high toxicity, since it was the only treatment that obtained a germination index of zero.

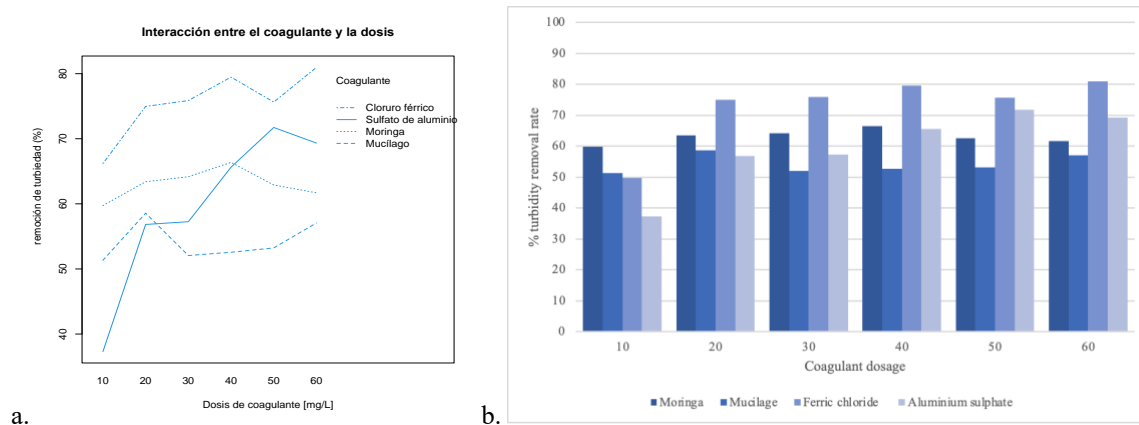


Figure 2. Evaluation of natural and commercial coagulants for the treatment of wastewater from drainage canals feeding the Endhó dam, Hidalgo, Mexico. a. interaction between coagulant and dosage; b. interaction in dosage and turbidity removal percentage.

According to the results obtained in the study, it can be confirmed that natural coagulants are efficient in reducing turbidity and removing pollutants from wastewater from drainage channels that feed the Endhó dam, highlighting that these are highly polluted waters, as they come from domestic, industrial, mining, agricultural and urban wastewater from the area with the largest population and industries in Mexico. Given the environmental problems in the study area, it is important to carry out research such as this one, which promotes the application of alternative and sustainable solutions for the treatment and use of wastewater as a possible solution to the great problem of water scarcity that the country is currently experiencing.

Reference: Balbinoti, J. R., dos Santos-Junior, R. E., Ferreira-de Sousa, L. B., Bassetti, F. J., Volpe-Babinoti, T. C., de Matos-Jorge, L. M. & Matos-Jorge, R. M. (2023). Plant-based coagulants for food industry wastewater treatment. *Journal of Water Process Engineering*, 52, 103525. <https://doi.org/10.1016/j.jwpe.2023.103525>

Chamizo-Checa, S., Otazo-Sánchez, E., Gordillo-Martínez, A., Suárez-Sánchez, J., González-Ramírez, C. & Muñoz-Nava, H. (2020). Megacity Wastewater Poured into A Nearby Basin: Looking for Sustainable Scenarios in A Case Study. *Water*, 12(3), 824. <https://doi.org/10.3390/w12030824>

García-Salas, E. M. (2020). El agua residual como generadora del espacio de la actividad agrícola en el Valle del Mezquital, Hidalgo, México. *Estudios sociales. Revista de alimentación contemporánea y desarrollo regional*, 29 (54). <https://doi.org/10.24836/es.v29i54.741>