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Removal Wastewater of Olive Mill by Coagulation Process

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ABSTRACT

Wastewater from the olive oil mill (OMW) is among the most difficult wastewater to treat because it contains toxic and persistent compounds, presenting a significant organic load and high turbidity. As part of our research, we studied the effectiveness of treating OMW through a coagulation process using both chemical and natural coagulants in batch mode. The physico-chemical analysis of OMW showed high levels of the initial chemical oxygen demand (COD) at approximately 240.9 g/L, as well as turbidity and polyphenols, with an initial concentration of around 5.7 g/L. The optimum turbidity removal rate is equal to 99.74 % is obtained when we are using the aloe vera (15 mL/L) solution with 37.5 g/L of Fenugreek. The proposed treatment process, which uses Aleo vera and Fenugreek as a biocoagulant, can be applied in many industries due to its unique characteristics, including cheap cost and environmentally friendly approach.

Keywords: Olive oil mill, wastewater, coagulation, turbidity.

1 Introduction

Virgin and extra virgin olive oils are produced in several Mediterranean industry areas, including Algeria, Spain, Italy, Tunisia, Turkey, Morocco and Greece (Babi´c et al., 2019). Many systems are used in the mechanical extraction process of olive oil. Around 5.4 10^6 m3 of olive oil mill wastewater (OMW) is produced annually through extraction technologies (Hodaifa et al., 2019). These effluents contain a substantial amount of suspended organic matter, which includes organic acids, polyalcohols, phenolic compounds, polysaccharides, nitrogen compounds, sugars, pectin, and lignin, among other elements (Malvis et al., 2019). The direct discharge of OMW into the surrounding area without any treatment potentially poses considerable ecological risks. Because of their high pollution load, their effects on soil, surface water, groundwater quality, and freshwater. The high concentration of toxic elements contributes to pollution (Babi´c et al., 2019). Physico-chemical methods are employed for the purification of OMW (Ochando-Pulido et al. 2017), biological processes (Chiavola et al. 2014), thermochemical treatments (Guida et al., 2016), and integrated processing (Malvis et al., 2019) or combined process (Khattabi Rifi et al., 2021).

One of the most effective and successful methods is coagulation/flocculation, which eliminates the majority of colloids in oily wastewater through flocculation (Zhao et al., 2021). The coagulation process involves faster mixing and coagulants inclusion into wastewater. Adding a flocculant converts light particles into heavy flocs, significantly improving the decantation process (Marichamy et al., 2021). The effectiveness of the coagulation process is affected by the coagulation agent used its concentration, the pH of the sample, and the availability of destabilizing anions and divalent cations such as chloride, bicarbonate, and sulfate ions (Ding et al., 2018). Synthetic organic or inorganic polymers are widely used in coagulation procedures for OMW treatment (Neffa et al., 2020). Many coagulants are dangerous to human health and the environment. Some mineral coagulants can cause Alzheimer's type neurological diseases (Owodunni and Ismail, 2021). Some research has suggested an association between exposure to aluminum and the development of neurological diseases (Bondy, 2016). It has been established that ferrous sulfate may present risks to human health, as it has been associated with neurological diseases such as Alzheimer's (Ibrahim et

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al., 2021a). Synthetic organic polymers like acrylamide are carcinogenic and neurotoxic (Mokhtar et al., 2019). In addition, traditional coagulants can produce sludge that cannot be removed by standard techniques, resulting in water and soil contamination. On the other hand, in the last few years, coagulants of natural origin have received increasing attention because they have many advantages; in particular, they are biodegradable without any impact on the environment (Lopes et al., 2019). The most used natural coagulants are chitosan (Maria et al., 2020) and *Moringa oleifera* (Camacho et al., 2017). Using natural coagulants lowers treatment costs, reduces sludge, and improves water quality (Nhut et al., 2020). The present investigation is intended to assess the efficiency of OMW treatment by the usage of chemical and natural coagulant for reducing pollution parameters at low cost.

2 Experimental

2.1 Olive oil mill wastewater collection

In February 2022, 100 L of untreated OMW were collected from an olive oil mill in the Chlef region. The sample is kept at 4 ◦C until analysis and used in treatment process in a closed plastic container.

2.2 Coagulation process

Laboratory-scale coagulation assessment was conducted with a sixseat Jar test device. The experiment's three steps are a quick mixing phase lasting five minutes at 150 rpm, 30 min of slow mixing at 30 rotations per minute, and a final decantation phase lasting an hour.

3 Results and Discussion

The Results of Fig 1 and table 1 indicate that the pollution parameter removal performance rate on coagulant process. When we used chemical coagulant (alumium sulfate-quicklime), the removal turbidity rate is equal to 99.17 % when the dose of alumium sulfate and quicklime are equal to 1 and 10 g/L. However, when we used natural coagulant (Aleo vera - fenugreek) the removal turbidity rate is equal to 99.74 % when the dose of aleo vera and fenugreek are equal to 15 mL/L and 37.5 g/L. Consequently, a turbidity elimination rate efficiency of 99,74 % was attained when we used a natural coagulant, reducing wastewater turbidity significantly.

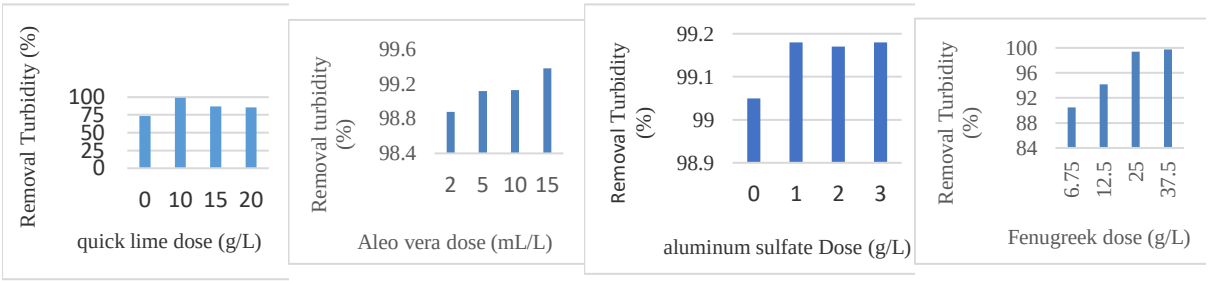

Figure 1: Evolution of parameter study on turbidity rate

In addition, table 1 indicates that the highest rate of reduction of pollution parameters is obtained by using biocoagulant.

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Table 1: *characterization of OMW before and after treatment*

N°	Parameters	O M W	After use chemical coagulant	After use biocoagulant
1	pH	4.25 ± 0.07	5.62 ± 0.05	5.82 ± 0.05
2	Turbidity (ntu)	18500 ± 2.7	153.55 ± 0.7	48.1 ± 0.5
3	Total Suspended Matter (g/L)	88.8 ± 1.5	23.088 ± 1.4	15.984 ± 1.4
4	Polyphenols (g/L)	5.7 ± 0.5	1.99 ± 0.3	1.56 ± 0.2
5	254 nm	400 ± 0.01	3.38 ± 0.01	2.50 ± 0.01
6	COD (g/L)	240.9 ± 1.1	101.17 ± 1.0	84.315 ± 1.0
7	$NH4^+$ (mg/L)	23.84 ± 0.09	7.63 ± 0.08	6.68 ± 0.05
8	$NO3^-$ (mg/L)	3100.4 ± 1.2	837 ± 1.1	527.07 ± 1.1
9	Total Phosphorus (mg/L)	450 ± 0.5	175.5 ± 0.4	130.5 ± 0.4

3 Conclusions

The OMW from Chlef is marked by an acidic pH of about 4.25, a high COD load (240.4 g/L), polyphenols of 5.7 g/L, nitrates of 3100.4 mg/L and Ammonium of 23.84 mg/L. The comparative study between chemical and natural coagulant indicate that combined bio - coagulation process with Aleo vera - fenugreek was significantly better in reducing the pollution parameters. Lastly, we can comment that aleo vera - fenugreek is a durable alternative to decrease inorganic coagulants in OMW processing, representing a more viable option for the olive oil production industries.

References

Babi´c, S., Malev, O., Pflieger, M., Lebedev, A.T., Mazur, D.M., Ku˘zi´c, A., ˘Co˘z-Rakovac, R., Treb˘se, P., Toxicity evaluation of olive oil mill wastewater and its polar fraction using multiple whole-organism bioassays. Sci. Total Environ. 2019, 686, 903–914.

Bondy, S.C., Low levels of aluminum can lead to behavioral and morphological changes associated with Alzheimer's disease and age-related neurodegeneration. Neurotoxicology, 2016, 52, 222–229.

Camacho, F.P., Sousa, V.S., Bergamasco, R., Teixeira, M.R., The use of Moringa oleifera as a natural coagulant in surface water treatment. Chem. Eng. J. 2017, 313, 226–237.

Chiavola, A., Farabegoli, G., Antonetti, F., Biological treatment of olive mill wastewater in a sequencing batch reactor. Biochem. Eng. J. 2014, 85, 71–78.

Ding, Q., Yamamura, H., Yonekawa, H., Aoki, N., Murata, N., Hafuka, A., Watanabe, Y., Differences in behaviour of three biopolymer constituents in coagulation with polyaluminium chloride: Implications for the optimisation of a coagulation–membrane filtration process. Water Res. 2018, 133, 255–263.

Guida, M.Y., Bouaik, H., Tabal, A., Hannioui, A., Solhy, A., Barakat, A., Aboulkas, A., El harfi, K., Thermochemical treatment of olive mill solid waste and olive mill wastewater. J. Therm. Anal. Calorim. 2016, 123 (2), 1657–1666.

Hodaifa, G., Gallardo, P.A.R., García, C.A., Kowalska, M., Seyedsalehi, M., Chemical oxidation methods for treatment of real industrial olive oil mill wastewater. J. Taiwan Inst. Chem. Eng. 2019, 97, 247–254.

Khattabi Rifi, S., Aguelmous, A., El Fels, L., Hafidi, M., Souabi, S., Effectiveness assessment of olive mill wastewater treatment by combined process: natural flotation and anaerobic-aerobic biodegradation. Water Environ. J. 2021, 35 (3), 986–997.

Lopes, E.C., Santos, S.C.R., Pintor, A.M.A., Boaventura, R.A.R., Botelho, C.M.S., Evaluation of a tannin-based coagulant on the decolorization of synthetic effluents. J. Environ. Chem. Eng. 2019, 7 (3), 103125.

Malvis, A., Hodaifa, G., Halioui, M., Seyedsalehi, M., S´anchez, S., Integrated process for olive oil mill wastewater treatment and its revalorization through the generation of high added value algal biomass. Water Res. 2019, 151, 332–342.

Maria, A., Mayasari, E., Irawati, U., Zulfikurrahman, Comparing the effectiveness of chitosan and conventional coagulants for coal wastewater treatment. IOP Conf. Ser.: Mater. Sci. Eng. 2020, 980 (1), 012077.

Marichamy, M.K., Kumaraguru, A., Jonna, N., Particle size distribution modeling and kinetic study for coagulation treatment of tannery industry wastewater at response surface optimized condition. J. Clean. Prod. 2021, 297, 126657.

Mokhtar, N.M., Priyatharishini, M., Kristanti, R.A., Study on the effectiveness of banana peel coagulant in turbidity reduction of synthetic wastewater. Int. J. Eng. Technol. Sci. 2019, 6, 82–90.

Neffa, M., Taourirte, M., Ouazzani, N., Hanine, H., Eco-friendly approach for elimination of olive mill wastewaters (OMW) toxicity using cactus prickly pears juice as a coagulant. Water Pract. Technol. 2020, 15, 1050–1067.

Nhut, H.T., Hung, N.T.Q., Lap, B.Q., Han, L.T.N., Tri, T.Q., Bang, N.H.K., Hiep, N.T., Ky, N.M., Use of Moringa oleifera seeds powder as bio-coagulants for the surface water treatment. Int. J. Environ. Sci. Technol. 2020, 18 (8), 2173–2180.

Ochando-Pulido, J.M., Pimentel-Moral, S., Verardo, V., Martinez-Ferez, A., A focus on advanced physico-chemical processes for olive mill wastewater treatment. Sep. Purif. Technol. 2017, 179, 161–174.

Owodunni, A.A., Ismail, S., Revolutionary technique for sustainable plant-based green coagulants in industrial wastewater treatment—A review. J. Water Process Eng. 2021, 42, 102096.

Zhao, C., Zhou, J., Yan, Y.i., Yang, L., Xing, G., Li, H., Wu, P., Wang, M., Zheng, H., Application of coagulation/flocculation in oily wastewater treatment: A review. Sci. Total Environ. 2021, 765, 142795.

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