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Electrocoagulation and nanofiltration integrated process application in purification of pistachio processing wastewater

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Abstract It is very challenging to treat raw pistachio processing wastewater (PPW) by one step process due to its high chemical oxygen demand (COD) and total phenols (TPh). In this study, treatment of PPW by electrocoagulation and nanofiltration integrated process was investigated as a function of voltage, time, and pH with stainless steel electrode as both anode and cathode. EC experimental design were carried out with two factors of the independent variables. Impact of current density (25-300 A/m^2) and reaction time (0-240 min) were systematically investigated on the removal of COD and TPh. Moreover, a commercial UF150-NF270-NF90 flat-sheet membranes were also used for further purification.

Keywords Electrocoagulation; Pistachio processing wastewater; Process optimization; Membrane Process; Treatment performance

INTRODUCTION

Pistachio (Pistaciavera) is a crustacean fruit from the family of mastic trees (Anacardiaceae) (Tekin et al., 2001). Turkey is located in one of the two pistachio gene centers and it is the second largest producer of pistachio in the world after the United States in 2016 (Ministry of Economy Report, 2016). Pistachio nuts are harvested as covered with organic hull (Açıkalın et al., 2012). The most important process (De-hulling) in the pistachio industry is soften the hull with water and to separate it from the pistachio. During this process, 8-10 L water is used per 1 kg of product and about 200 g wet crust is formed (Shamsi et al., 2011). Pistachio processing wastewater (PPW) containing high chemical oxygen demand (COD), total phenol (TP), and turbidity damage particularly terrestrial and aquatic ecosystems if it is discharged without treatment (Celik et al., 2015).
In recent years, electrochemical treatment methods have been proposed for the treatment of wastewaters containing toxic organic and inorganic substances which cannot be treated by conventional treatment methods. Electrochemical methods used for the treatment of domestic and industrial wastewaters consist of coagulation, adsorption, absorption, precipitation, and flotation processes (Ihara et al., 2004).
In this study, a combined process including EC process combined with membrane process was used to treat PPW. The novelty is the use of EC process as a pre-treatment method and combining with membrane process to remove COD and TP and to recovery of water for de-hulling process.

MATERIAL AND METHODS

Pistachio Processing wastewater (PPW)

The composite raw wastewater samples were kindly provided from a local pistachio processing factory in Gaziantep, Turkey as a composite sample (Figure 1). The characteristics of PPW are given in Table 1.

Figure 1. Raw pistachio processing wastewater (PPW)

Table 1. The characteristics of PPW after EC and membrane filtration (Ozay et al., 2018).

Parameter	Unit	Raw	After EC	NF90Permeate
pH	-	4.84±0.25	8.62±0.25	8.92±0.15
Conductivity	mS/cm	7.68±0.3	7.95±0.1	0.25±0.05
COD	mg/L	24,640±530	12,591±150	172±10
Total Phenol	mg/L	3,000±115	1,233±22	6±1

EC and membrane process experimental setup

EC experiments of PPW were performed in a 1100 mL glass reactor with a working volume of 800 mL. Stainless steel electrodes (8x5 cm) were used to compare COD and TP removal efficiency. Pistachio processing factory wastewater without any dilution was loaded into the reactor and the reaction under pre-determined conditions was started (Figure 2). Membrane experiments were performed in a stainless-steel cylindrical stirred batch cell, dead-end filtration module (Sterlitech HP4750 Stirred Cell). This module can be used up to 69 bar pressure for circular flat sheet membranes (UF150-NF270-NF90) with a diameter of 4.3 cm and an effective filtration area of 0.00146m^2. The volume of the cell was 250 mL. Experimental conditions of membrane process are given in Table 2.

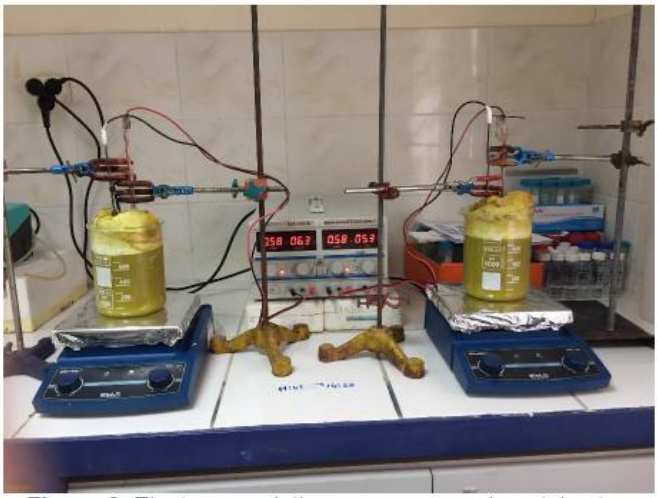

Figure 2. Electrocoagulation process experimental setup

Table 2. Experimental conditions of membrane process

Membrane	UF150			NF270			NF90		
Pressure (Bar)	2,5	5,0	7,5	10	15	20	20	30	40
pH	6,0	7,5	8,6	6,0	7,5	8,6	6,0	7,5	8,6
Recovery (%)	80			75			75		

RESULTS AND DISCUSSION

With EC experimental design, removal efficiency of 48,9 and 58,9% of COD and TPh, respectively, was obtained with the current density of 300 A/m2 and reaction time of 240 min. Pre-treated PPW was further treated by membrane process. Flux depends on pressure is given in Figure 3. It could be seen that 2.5 bar did not have sufficient flux whereas 5.0 and 7.5 bar pressure values did not show a significant difference in terms of flux values (Figure 3). For this reason, 5 bar was chosen as the optimum pressure value.

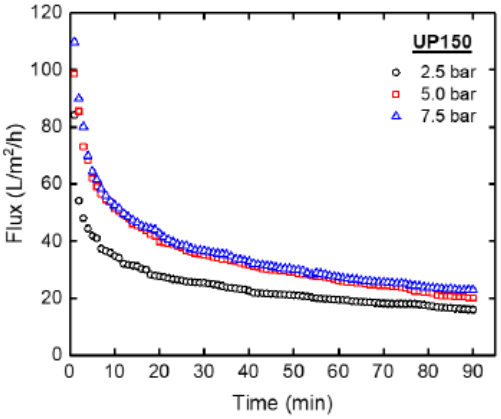

Figure 3. Flux results of UF150 membrane

Flux depends on pressure is given in Figure 4 for NF270 membrane. It could be seen that 20 bar showed higher flux than 10 bar. For this reason, 20 bar was chosen as the optimum pressure value.

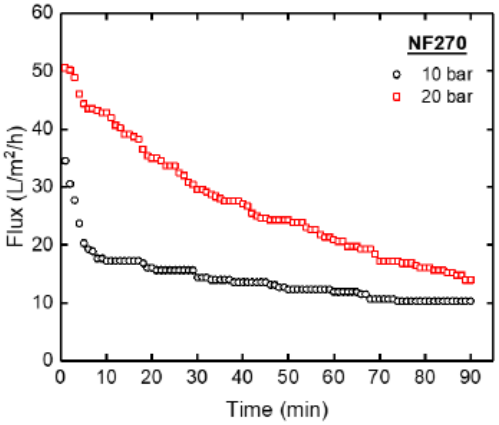

Figure 4. Flux results of NF270 membrane

NF90 membrane supplied the best results for recovery of water after EC process. It could be seen that 98.5% COD and 99.5% total phenol was obtained by NF90 membrane filtration. Flux results of NF90 membrane are presented in Figure 5.

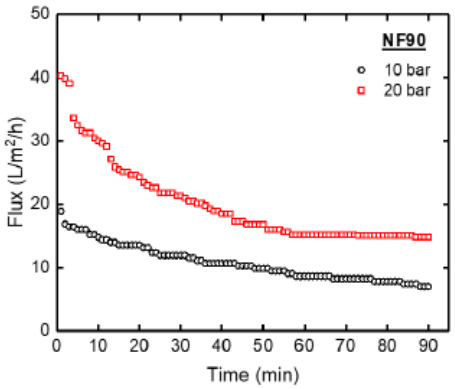

Figure 5. Flux results of NF90 membrane

Experiments were repeated with UF150, NF270 and NF90 membranes in optimal operating conditions in order to observe the change in membrane flux during water recovery from untreated wastewater (Figure 6).

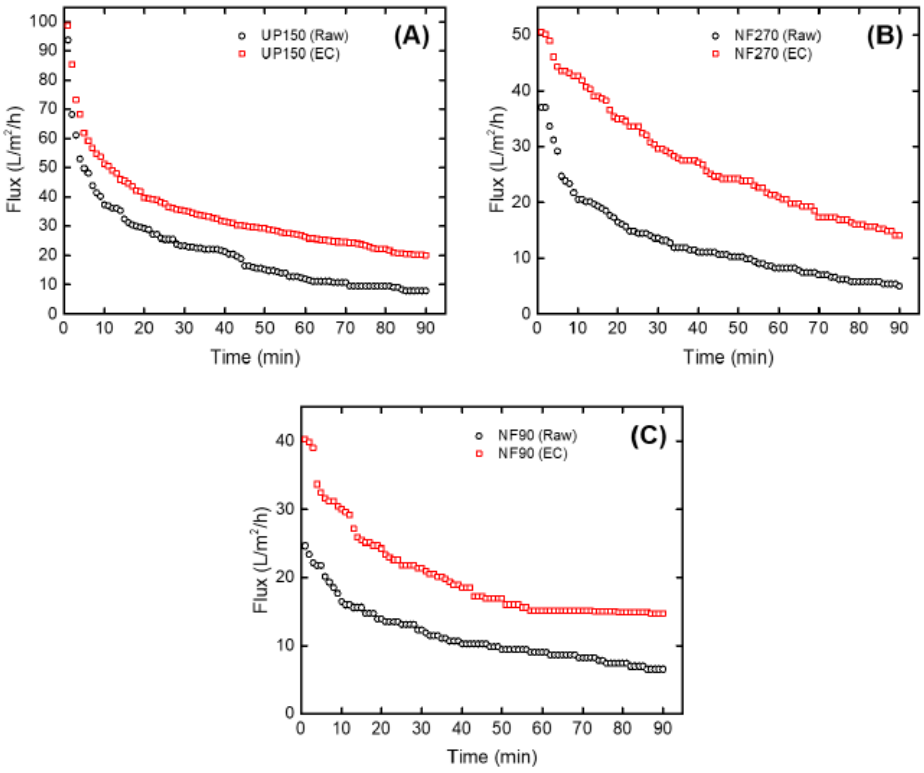

Figure 6. Comparison flux of raw PPW and after EC pre-treatment (UP150: 5 bar; NF270: 20 bar; NF90: 40 bar)

Maximum COD (99.3%) and TPh (99.8) removal efficiency results of NF90 membrane were obtained with original pH (8,6) and 40 bar of pressure (Figure 7).

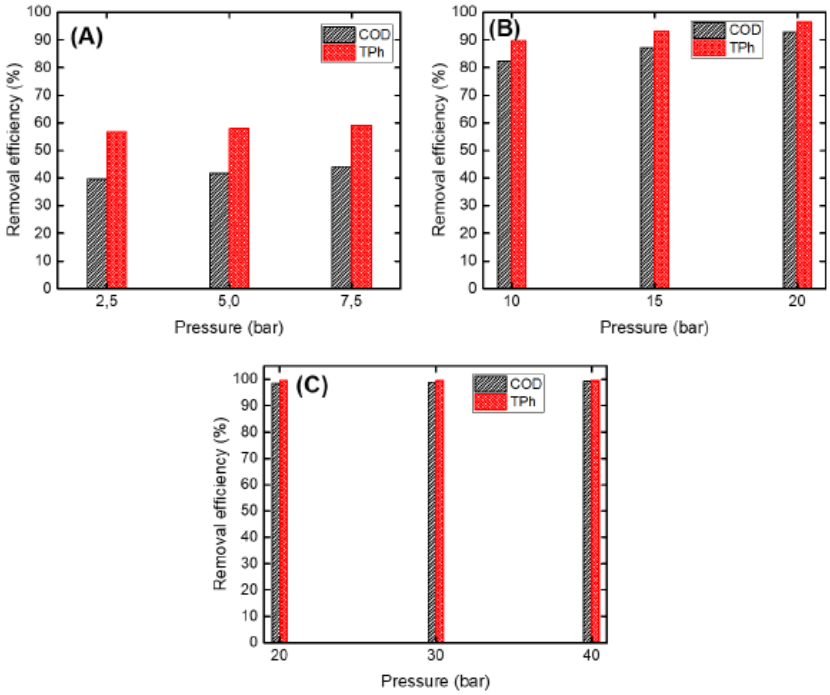

Figure 7. Maximum COD and TPh removal efficiency of the membranes

CONCLUSIONS

The electrocoagulation treatment coupled with the membrane treatment system as a pre- treatment was evaluated to be an attractive option to achieve the water quality required for water reuse applications in pistachio de-hulling process.
It was shown that the most suitable condition for water recovery from the pistachio processing plant wastewater was obtained by the experiments carried out with the electrochemical pretreatment of the wastewater with NF90 membrane and the water at the original pH and pressure of 40 bar.

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REFERENCES

Açıkalın, K., Karaca, F., Bolat, E., 2012. Pyrolysis of pistachio shell: effects of pyrolysis conditions and analysis of products. Fuel 95, 169-177.
Tekin, H., Arpacı, S., Atlı, H.S., Açar, I., Karadag, S., Yükçeken, Y., Yaman, A. (2001). Antepfıstığı yetiştiriciliği, Antepfıstığı araştırma enstitüsü müdürlüğü, Gaziantep 13, 132.
Ministry of Economy e Report, 2016. Republic of Turkey Ministry of Economy Report. Sector reports - pistachio, Turkey.
Shamsi, M., Alavi, N., Mazloumzadeh, S.M., Rokabi, M., 2011. Journal of Agricultural Technology 7 (1), 57-62.

Ozay, Y.,Unsar, E., Isik, Z., Yılmaz, F., Dizge, N., Perendeci, A., Mazmanci, M., Yalvac, M., 2018 Optimization of electrocoagulation process and combination of anaerobic digestion for the treatment of pistachio processing wastewater