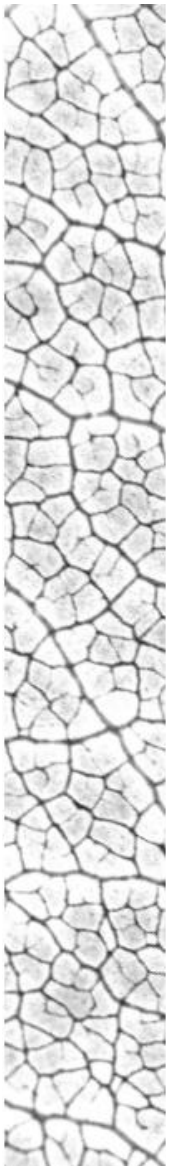

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Removal of COD and TOC from domestic wastewater by using alum and peels of sunflowers seeds as natural coagulant

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Abstract
In this paper, the processes of coagulation and flocculation were employed for removing of organic matters expressed as total organic compounds (TOC) and chemical oxygen demand (COD) from domestic wastewater. Two types of coagulants were used alum (Aluminum sulfate ($Al_2(SO_4)_3.18H_2O$)) and peels of sunflowers seeds which is used as natural coagulant. Jar test experiment was used in this study. The doses of coagulants (alum and peels of Sunflowers seeds) were 1, 2, 3, 4, 5 and 6 g/l, which added to the beakers for each coagulant. The experiments were conducted in two stages at the same operation conditions, the first stage was done using alum and the second stage was conducted using Peels of Sunflowers seeds. The results pointed that the maximum removal efficiency of COD using alum was 84.412 with dose of 6 g/l, while for natural coagulant (peels of sunflower seeds) was 54.436 at the same dose. The maximum removal efficiency of TOC using alum and peels of sunflower seeds were 64.336 and 36.302, respectively at the same dose 6 g/l. The results revealed that the removal efficiency of both COD and TOC affected by doses of coagulant so that the removal efficiency of COD and TOT increase as doses of coagulant increase. The removal efficiency of COD and TOC is higher for alum than peels of Sunflowers seeds.

Keywords: wastewater, COD, TOC, coagulation, flocculation

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INTRODUCTION

In view of the increasing awareness of pollution problems, the spreading of organic pollution in the environment has become a source of concern. The increasing use of chemical compounds and related compounds in every area of industry and agriculture is increasingly becoming an urgent need for the effective removal of water and wastewater (Patel and Vashi, 2013; Zelalem, et al, 2018). Contamination with organic compounds in the wastewater comes from human activities such industrial, domestic and agricultural and need to advanced treatment before discharging it's into the environment because of the ecological risk to humans and animals (Aboussabiq et al, 2014). In general untreated wastewater includes high levels of organic matters, heavy metals, numerous toxic compounds and pathogenic microorganisms (Ismail et al, 2012). The most techniques that are widely used Wastewater treatment are Coagulation, chemical precipitation, lime, ion exchange, reverse osmosis and solvent extraction (Deshpande and Thorvat, 2018; Kumar et al, 2017; Roy et al, 2018). The most popular process used for treating of water and wastewater is Coagulation. It is effective method for removing of particles as well as organic materials. Coagulation is primarily used to reduce turbidity, and then limit of organic matter has become a target of coagulation (Radhi and Borghei, 2017; Loloei, et al, 2013; Ayguna and Yilmaz, 2010). Coagulation is one of the most important physicochemical processes used in water and wastewater treatment which can be carried out through chemical and electrical means. Coagulation and flocculation occur in progressive steps designed to overcome the forces stabilizing the suspended particles, allowing particle collision and growth of floc (Sahu and Chaudhari, 2013). Coagulation-flocculation can be used for removing of turbidity in addition to other contaminants such as BOD, color, dissolved organic carbon (DOC), COD, heavy metals, microorganisms, TSS, grease and oil (Onukwuli et al, 2019; Meri et al, 2002). Flocs form in coagulation and flocculation

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Table 1. The characteristics of wastewater samples

Parameters	Value
pH	8.7
COD (mg/l)	834
TOC (mg/l/)	563.6
Temp (C^0)	32
Temperature (T)	25.6

Table 2. Experimental conditions for the jar test in this study

Characteristic	Description
Coagulant dose	(1,2,3,4,5 ,6) g/l
pH	8.7
Rapid mixing time	2.0 min at 250 (rpm)
Slow mixing time	20 min at 40 (rpm)
Settling time	30 min

Fig. 1. Peels of sunflowers seeds powder

process, through addition of coagulation salts to water. The formative flocs deposit in water faster than small particles (Ahmad et al, 2016). Coagulant is a chemical added to the water to withdraw the forces that stabilizes the colloidal particles and causing the particles to suspend in the water (Saravanan et al, 2017). The popular coagulants used in water and wastewater treatment are the inorganics such as aluminum and iron salts (Wolf et al, 2015). Aluminum sulfate is the most widely used coagulant. Its efficiency depends on the chemical and physical characteristics of the raw water and the operating conditions such as pH and coagulant dose (Lanciné et al, 2008). In this study the possibility of using alum and natural coagulants to remove chemical oxygen demand (COD) and total organic compound (TOC) from wastewater has been studied. (Rezapour-Nasrabad, 2020)

MATERIALS AND METHODS

In this study two types of coagulants were used to remove of COD and TOC from wastewater. The first one is alum (Aluminum sulfate (Al_2 $(SO_4)_3.18H_2O$)) and the second one is peels of sunflowers seeds which is used as natural coagulant. The preparation of natural coagulant involved cleans of the peels of sunflowers seeds with distilled water, drying it by oven and then crushed it to be as **Fig. 1**. The samples of wastewater were collected from household wastewater. The

Fig. 2. Jar-Test equipment used during the study

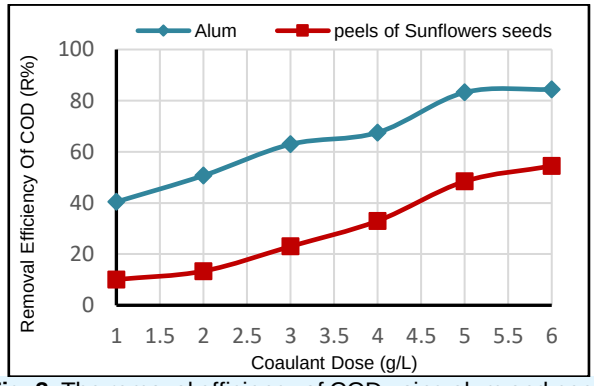

Fig. 3. The removal efficiency of COD using alum and peels of Sunflowers seeds with coagulant dose, Rapid mixing=2min., slow mixing=20 min, settling time=30min and pH=8.7, initial COD (834mg/l)

characteristics of wastewater samples are shown in **Table 1**. Jar test procedure was adopted in this study **Fig. 2**. The doses of coagulants (alum and peels of sunflower seeds) were 1, 2, 3, 4, 5 and 6 g/l, which added on the beakers for each coagulant. The experiments were conducted in two separated stages at the same operation conditions. The first stage was done using alum alone and the second one was conducted using Peels of Sunflowers seeds alone. The operation conduction are: rapid mixing time of 2min with blending speed of 250 rpm, time of slow mixing is 20 min with speed of mixing 40 rpm, and settling time is 30 min. Experimental condition for jar test which used in this study are shown in **Table 2**.

RESULTS AND DISCUSSION

Fig. 3 shows the removal efficiency of COD using alum and peels of sunflowers seeds with dosages of 1, 2, 3, 4, 5 and 6 g/l. The maximum removal efficiency of COD using alum was 84.412 with dose of 6 g/l, while for natural coagulant (peels of Sunflowers seeds) was 54.436 at the same dose. **Fig. 4** shows the removal efficiency of TOC using alum and peels of Sunflowers

Table 3. The characteristics of wastewater samples

Dose (g/l)	Alum				Peels of Sunflowers seeds			
	COD (mg/l)	Removal (R %)	TOC (mg/l)	Removal (R %)	COD (mg/l)	Removal (R %)	TOC (mg/l)	Removal (R %)
1	496.8	40.43	511	9.333	750	10.07	530	5.96
2	411.1	50.71	464	17.67	722.6	13.36	492.5	12.61
3	309	62.95	380	32.57	642	23.02	440	21.93
4	270.8	67.53	351	37.72	559	32.97	401	28.85
5	140	83.21	349.9	37.92	430.1	48.43	390.2	30.77
6	130	84.41	201	64.34	380	54.44	359	36.30

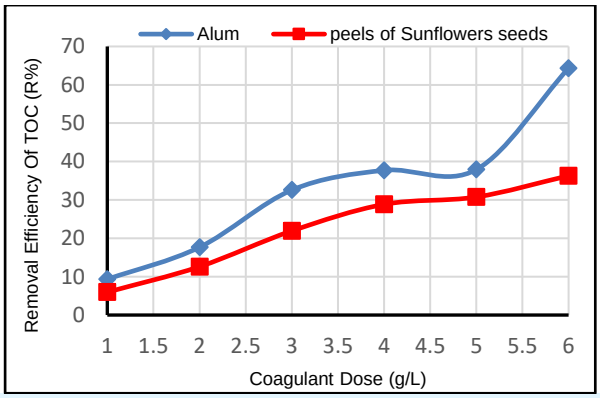

Fig. 4. The removal efficiency of TOC using alum and peels of Sunflowers seeds with coagulant dose, Rapid mixing=2min., slow mixing=20 min, settling time=30min and pH=8.7, initial TOC (563.6 mg/l)

seeds with doses of 1, 2, 3, 4, 5 and 6 g/l. The maximum removal efficiency of TOC using alum and peels of Sunflower seeds were 64.336 and 36.302, respectively at the same dose 6 g/l. **Table 3** shows a summary of results in this study. The results showed that the removal efficiency of both COD and TOC affected by doses of coagulant so that the removal efficiency of COD and TOC increase as doses of coagulant increase. The removal efficiency of COD and TOC is higher for alum than peels of sunflower seeds.

CONCLUSION

The removal efficiency of COD and TOC increased by increasing the dose of coagulants. The removal efficiency of COD and TOC is higher for alum than peels of Sunflowers seeds. According to the results both alum and peels of sunflower seeds can be used to remove of the organic matters (COD and TOC) with different values of removal efficiency for certain dose. For future studies on the same topic the other conditions of the experiment in addition to coagulant dose can be used for increasing of the removal efficiency of organic matter such as using different value of pH or increasing of the rapid mixing, slow mixing and settling time which can contribute to make the natural coagulant more effective for removing of COD and TOC from wastewater.

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