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Original Article

The removal efficiency of natural nano-coagulant produced from *Phragmites communis*, *Schanginia aegyptiaca* and *Portulaca oleracea* in wastewater treatment

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Abstract: Sewage water contains suspended and dissolved solids, hydrocarbons, many types of organic matter and heavy metals. The reuse of wastewater faces the challenge of removing organic pollutant compounds before discharging them into any natural stream. Therefore, in this study, natural nano-coagulant materials were used and their efficiency in removing turbidity, total organic carbon (TOC), and chemical oxygen demand (COD) from wastewater were investigated. The natural nano-coagulant were synthesized using leaves of *Phragmites communis*, *Schanginia aegyptiaca* and *Portulaca oleracea*. The results showed that 0.5 mg/L of *P. oleracea* nano-coagulant can remove 96.3% of COD, 86.2% of TOC and 89.5% of turbidity. Also, *S. aegyptiaca* leaves' nano-coagulant in the 1 and 0.5 mg/L concentration was removed turbidity, COD and TOC content of the wastewater by 93.1, 89.42, and 81.8%, respectively. Moreover, *P. communis* leaves removed TOC, COD, and turbidity up to 78.2, 83.48, and 86.18%, respectively. The results showed the efficiency of natural nano-coagulant materials in treating and depositing wastewater pollutants.

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Introduction

Water contamination is growing at an alarming rate, and the most important cause of pollution is the discharge of wastes resulting from human activities. Most of these wastes are rich in nutrients, causing eutrophication (Guda et al., 2019). Although maintainable water administration techniques are recognized worldwide, water resources face a serious threat from receiving a wide range of pollutants. This required more attention to wastewater treatment and ensuring that this is suitable to meet local conditions for pollution sources and wastewater treatment frameworks.

The evacuation of major poisons such as suspended solids, biological oxygen demand (BOD), supplements (organic and inorganic) and coliform microbes are the main objectives of wastewater filtration (Fakhrul-Razi et al., 2009). Colloidal materials can be eliminated from treated water using numerous methods, such as coagulation, flocculation, adsorption, particle trade, buoyancy, film, sedimentation, dissolvable extraction, natural filtration, and electrolysis strategies (Guda et al., 2018). Coagulation is among the accessible water treatment strategies and is straightforward, dependable, and low-cost (Oladoja, 2015). It is an effective way to treat water pollutants and has been widely used to treat different types of wastewater such as water from mills, sanitary waste from hospitals, and domestic wastewater (Tatsi et al., 2003; Yue et al., 2008) since it does not require complex machines, many manpower, and no need for energy consumption. This method can remove colloidal, soluble and suspended pollutants and other pollutants such as natural compounds, color, micro-pollutants, fats, and oils through the collection of fine particles until large particles of size are formed that can be deposited (Oladoja, 2015).

In the nano-coagulation method, small particles are formed into large aggregates (lumps) and the broken-up natural matter will be retained. This is often taken after expelling bigger particles by simple filtration or

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Table 1. Characteristics of natural nano-coagulants by (AFM) microscope.

Nanoparticle	Average diameter (nm)	50% diameter (nm)	Particles size distributions (nm)	Roughness average (nm)	Root mean square (nm)
P. oleracea	112.7	80	40-180	0.74	1.09
S. aegyptiaca	98.7	85	65-135	0.38	0.68
P. communis	76	60	70-155	1.17	1.04

sedimentation, reducing natural matter and turbidity (Yin, 2010). There is a particular definition for coagulation and flocculation, but it is worthy to refer to both forms as coagulation in wastewater treatment (Jiang, 2007). Coagulation incorporates the taking after several stages, including thrombus formation, particle instability and particle aggregation (Jiang and Graham, 1998). Natural coagulants collect particles and masses by adsorption on their surfaces. Four coagulation instruments occur within the molecule to prepare twofold layer compression, viz. clear flocculation, adsorption, charge neutralization, and adsorption and molecule fascination (Yin, 2010). Aluminum and iron salts are the most common nanomaterial used to treat wastewater (Guda et al., 2017). However, they cause negative effects on human health, such as losing memory when aluminum is used as a coagulant in treated water treatment. The current trend is to use environmentally friendly coagulated nanomaterial (Muthik et al., 2019; Hussein et al., 2019).

Plants, animals, and minerals are natural sources for producing nanomaterial and the common natural coagulants are made from plants due to their suitability for mass production and applicability, and being non-toxic, renewable, producing less degradable sludge, relatively cost-effective and do not change the pH value of the treated water (Fakhrul-Razi et al., 2009; Muthik et al., 2018; AL-Bayati, 2019; Kumar et al., 2019). Therefore, the present study aims to produce nanomaterial from the leaves of *Phragmites communis*, *Schanginia aegyptiaca*, and *Portulaca oleracea* as natural nano-coagulants in wastewater treatment.

Materials and methods

Treatment of plant: Leaves of *P. communis, S. aegyptiaca* and *P. oleracea* were collected and washed with deionized water several times to remove the impurities. 100 g of dried leaves were taken and put in an oven at 60°C until their weight stability, then placed in an airtight carton box, away from moisture. The dried leaves were ground into a fine powder and sieved using a 600 μm sieve (Yue et al., 2008). 25 ml of 70% ethanol were added to a separating funnel, and after stirring for two hours, the sediment was left, and the supernatant was taken and dried. Purified water was included in the powder to get a suspension of 1%, and shaken for 45 min to extract the coagulation proteins and then passed through the Whatman filter paper. This was used as a coagulant stock for the experiment. The stock should be prepared daily and kept in the fridge to eliminate any impact, such as changing the thickness, coagulation movement, and pH. It must be shaken well before use. The Nuclear Constrain Magnifying (AFM) microscope was used to examine the structural arrangement of the nanomaterials, normal distance, and disseminations. The AFM features images of the prepared nano-materials in 2D.

Collecting water samples: Samples of the untreated water were collected from the wastewater in Barakia, Najaf Governorate, Iraq, on 15 October 2020, as three replications from the main sedimentation tank using clean containers.

Physical and chemical parameters of samples: The pH and EC were measured using a multi photometer and turbidity by a turbo meter. All the devices were laboratory calibrated before starting the measurements. Total dissolved solids (TDS), total organic carbon (TOC), biochemical oxygen demand (BOD5) and chemical oxygen demand (COD) were measured based on Wong et al. (2006).

Jar test: The jar test was performed to study the potency of nano-coagulants. The treated water characteristics in the experiments are shown in Table

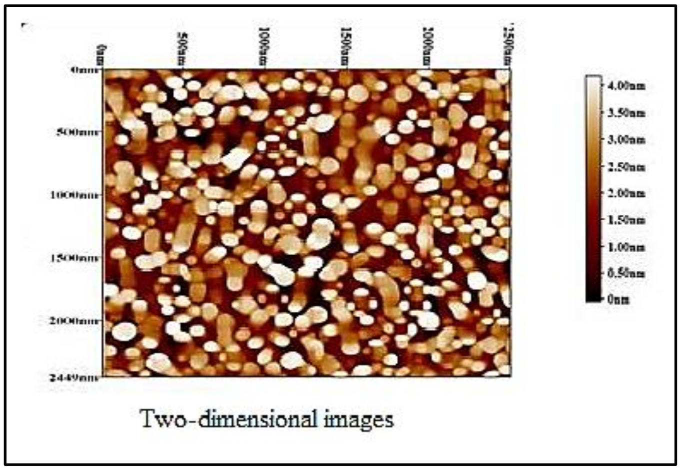

Figure 1. 2D image of *P. oleracea* as natural nano-coagulants by (AFM) microscope.

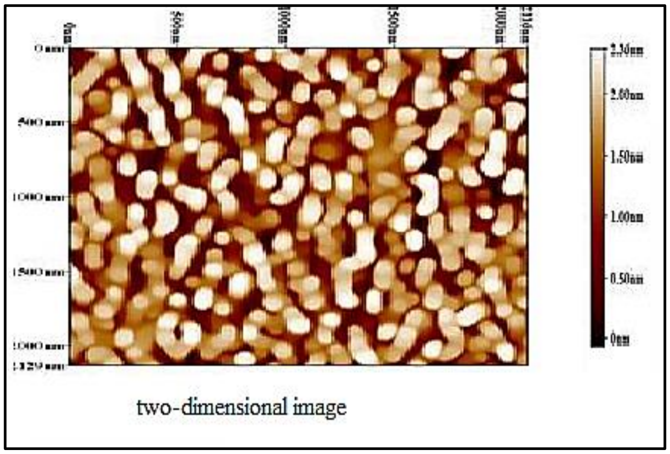

Figure 2. 2D image of *S. aegyptiaca* as natural nano-coagulants.

1. Natural nano-coagulants were used at room temperature and the sample were mixed well before use. One liter of water was taken, the experiment substance was added, mixed at 150 rpm for 1 min, then mixed slowly at 50 rpm for 20 min, and finally leaves the sample to settle for 15 min. Coagulants were added at different concentrations of 0.5-3 ppm to determine the best dose based on the minimum contaminant concentration. Experiments were performed in the pH range of 3-10 to determine the best pH value.

Statistical analysis: Data were analyzed using ANOVA in SPSS (Ver.17) software. LSD was used to calculate the significance of the means.

Results and Discussions

Diameter and size are shown in the two-dimensional images of the prepared natural nano-coagulants nanomaterials (Table 1, Figs. 1, 2, 3).

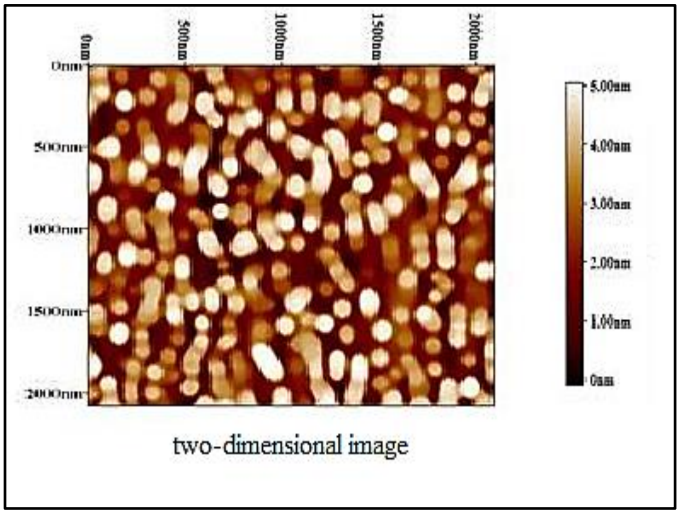

Figure 3. 2D image of *P. communis* as natural nano-coagulants.

Determination of optimum doses of coagulants: The required optimal dose for different natural nano-coagulants to reduce turbidity is shown in Figure 4. the increasing natural nano-coagulants concentration increases the efficiency until it reaches an optimum point. The optimum concentration for *P. oleracea* was 0.5 mg/L, for *S. aegyptiaca* 1 mg/L, and 1.5 mg/L for *P. communis*. The highest removal rate was recorded in *P. oleracea* at 89.5%, *S. aegyptiaca* at 89.42%, and *P. communis* at 86.18%.

The optimum dose for TOC removal: The optimum dose for *P. oleracea, S. aegyptiaca* and *P. communis* was 1 mg/L. Based on the results, exceeding the optimum dose leads to destabilization, which weakens the attraction between the organic materials. This causes a decrease in the stability velocity of the particles according to the stock law, causing a decrease in the removal efficiency (Jiang, 2007). The highest removal rate was in *P. oleracea* with a TOC removal rate of 86.2 %, then *S. aegyptiaca* (81.8%), and *P. communis* (78.2%) (Fig. 5).

The optimum dose for the removal of COD: The optimum dose for *P. oleracea* and *S. aegyptiaca* was 0.5 mg/L, and for *P. communis* was 1.5 mg/L. The use of natural coagulant nanomaterials increases sludge formation, and by exceeding the optimal limits, colloids were not stabilized in the treated water and thus increased (Jiang and Graham, 1998). The highest removal rate was found in *P. oleracea* with a rate of

Table 2. Initial characteristics of the treated water that was used in the experiment.

Parameters	Range
COD (mg/L)	1457-28609
BOD5 (mg/L)	260-308
TDS (mg/L)	99800
TOC (mg/L)	60-9000
Turbidity (NTU)	441
pH	7-7.3
Electrical Conductivity (EC) (dS/m)	6.55

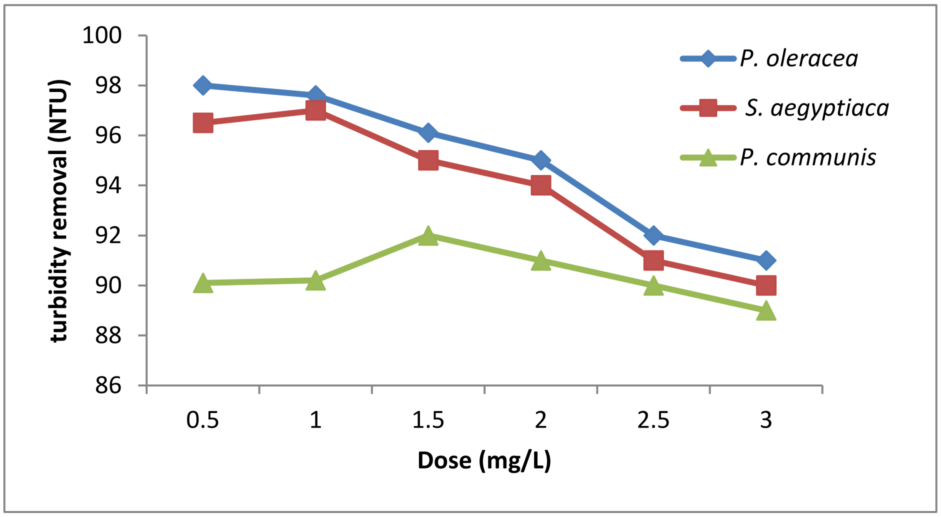

Figure 4. Removal of turbidity from treated water by the influence of natural nano-coagulants particles.

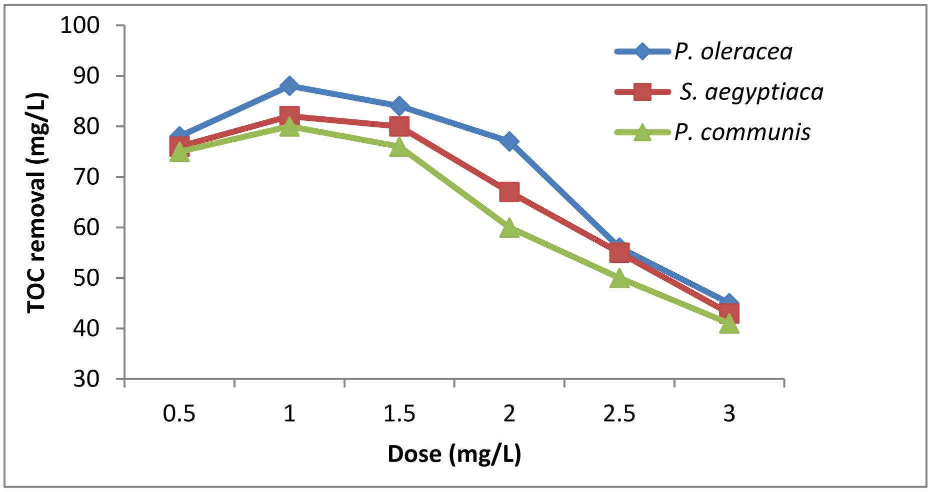

Figure 5. The removal of TOC from treated water by the influence of natural nano-coagulants particles.

96.3 %, then *S. aegyptiaca* (93.1%) and *P. communis* (83.48%) (Fig. 6).

Comparing the optimal results of nano-coagulation dose of the three experimental plants showed that *P. oleracea* had the best removal rate for turbidity, TOC, and COD. *Schanginia aegyptiaca* had almost similar results with *P. oleracea* in removal percentage (Fig. 7).

The use of leaves of three examined plants in this work can be efficient in manufacturing nano-coagulate materials that can be applied to treat wastewater to remove turbidity, TOC and COD. The highest removal percentage of TOC, COD and turbidity were recorded 86.2, 96.3, and 89.5%, respectively, when using *P. oleracea*.

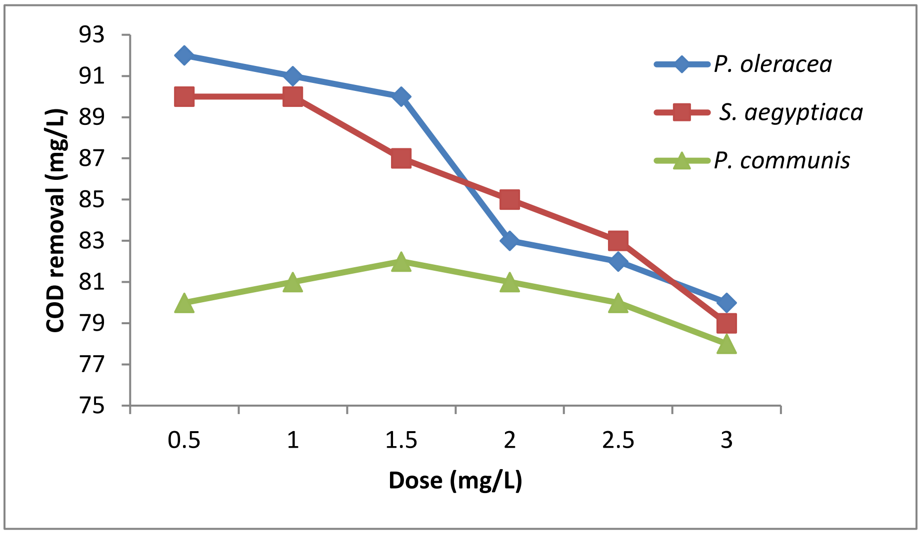

Figure 6. Removal of COD from treated water by the influence of natural nano-coagulants particles.

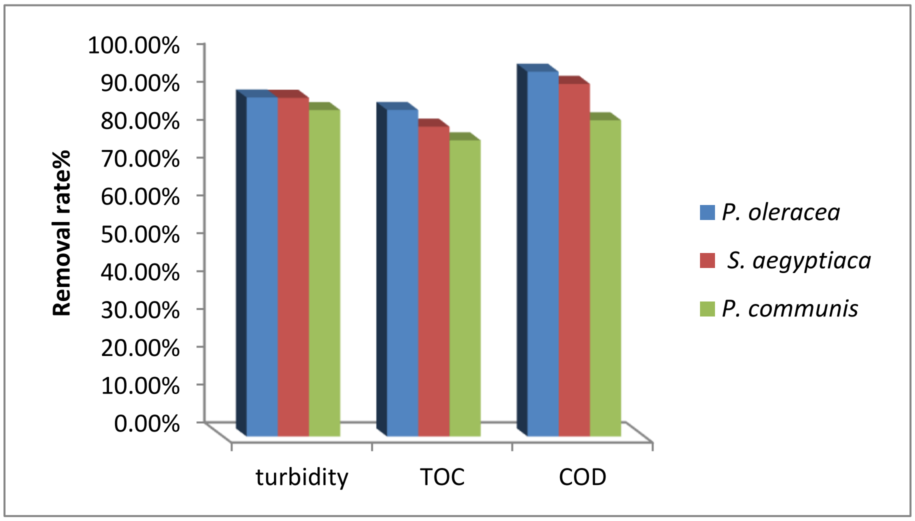

Figure 6. Comparison between plants used in syntheses natural nano-coagulants under optimal conditions

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References

Ahmad A.L., Ismail S., Bhatia S. (2005). Optimization of coagulation–flocculation process for palm oil mill effluent using response surface methodology. Environmental Science and Technology, 39(8): 2828-2834.

AL-Bayati H.J.M. (2019). Growth and yield of cauliflower as affected by boron and fertilizer type. International Journal of Agricultural and Statistical Sciences, 15(2): 595-599.

Fakhrul-Razi A., Pendashteh A., Abdullah L.C., Biak D.R.A., Madaeni S.S., Abidin Z.Z. (2009). Review of technologies for oil and gas produced water treatment. Journal of Hazardous Materials, 170(2-3): 530-551.

Guda M.A., Nasir A.S., Younus A.S., Altamimi A.J. (2018). Antioxidant Enzyme Responses of *Juncus aschers* (EtBuch.) Adoms to Some of Environmental Stresses and use it as Indicators. Indian Journal of Public Health Research and Development, 9(12): 1-9.

Guda M.A., Hakeem G.L., Alabassi M.M., Hamad M.O., Naji H.A. (2019). Investigation use irradiation to treat west water and their effects on plants. Journal of Al-Hussein Bin Talal University for Research, 5(5): 3567-3578.

Guda M.A., Hakeem J.I., Alabassi M.M., Almayahi B.A. (2017). Effects of Environmental Stress on Nutrients of *Typha domingensis* Pers. Plant in Najaf, Iraq. Annual Research and Review in Biology, 1-6.

Hussein A.M., Alshukri A.Y., Mohammed A.E. (2019).

Susceptibility of *Pleurotus ostreatusto* growth on wheat, water hyacinth, barley straw and biodegrade its residues. International Journal of Agricultural and Statistical Sciences, 15(2): 585-589.

Jiang J.G. (2007). Development of coagulation theory and pre- polymerized coagulants for water treatment. Separation and Purification Methods, 30(1): 127-141.

Jiang J.Q., Graham N.J.D. (1998). Pre-polymerised inorganic coagulants and phosphorus removal by coagulation-A review. Water SA, 24 (3): 237-244.

Kumar A., Dutt B.D., Kumar V. (2019). Groundwater quality assessment in river Hindon catchment of Saharanpur, Uttar Pradesh, India. International Journal of Agricultural and Statistical Sciences, 15(1): 415-421.

Oladoja N.A. (2015). Headway on natural polymeric coagulants in water and wastewater treatment operations. Journal Water Process Engineering, 6: 174-192.

Tatsi A.A., Zouboulis A.I., Matis K.A., Samaras P. (2003). Coagulation–flocculation pretreatment of sanitary landfill leachates. Chemosphere, 53(7): 737-744.

Wong S.S., Teng T.T., Ahmad A.L., Zuhairi A., Najafpour G. (2006). Treatment of pulp and paper mill wastewater by polyacrylamide (PAM) in polymer induced flocculation. Journal of Hazardous Materials, 135: 378-388.

Yin C.Y. (2010). Emerging usage of plant-based coagulants for water and wastewater treatment. Process Biochemistry, 45(9): 1437-1444.

Yue Q.Y., Gao B.Y., Wang Y., Zhang H., Sun X., Wang S.G., Gu R.R. (2008). Synthesis of polyamine flocculants and their potential use in treating dye wastewater. Journal of Hazardous Materials, 152: 221-227.

Banoon S.R., Ghasemian A. (2021). The characters of graphene oxide nanoparticles and doxorubicin against HCT-116 colorectal cancer cells in vitro. Journal of Gastrointestinal Cancer, 1-5.