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Simultaneous Mitigation of Wastewater Pollutants Utilizing Greener Process

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Abstract

The utilization of *Moringa Oleifera* (MO) seed extract and blue-green algae allows us to develop an environmentally friendly (green) to purify wastewater and reduce its environmental risks. The primary aim of this study is to use the MO seeds and blue-green algae as a natural greener adsorbent to mitigate chemical and microbial pollutants from wastewater. Accordingly, water quality from the El-Rahawy drain was examined before and after the treatment using MO seed and MO & algae. MO seed displayed high removal efficacy in lessening and preventing inorganic and organic pollutants in El-Rahawy drain samples. Water turbidity was removed up to 80–92% from a concentration of 11-23 NTU and dissolved oxygen (DO) was improved by 58% from 0.1-4 mg/L. The chemical oxygen demand (COD) and biological oxygen demand (BOD) were increased after the addition of the MO seed extract, whereas mixing the MO and algae reduced the increase done by the seed extract. Nevertheless, there was no significant alteration in pH, conductivity, salinity, and total dissolved solids after the treatment. Copper, barium, and iron were eliminated entirely, whereas aluminum, cobalt, lead, manganese, and coliforms were successfully removed by up to 90%. Adding algae to MO seeds generally enhances the efficiency of pollutant removal. In general, adding 0.3 g of algae to 70 ml of MO seed cake was adequate to eliminate impurities from the wastewater samples. Regeneration was also attempted for several cycles in order to return the sorbent to its original state by 0.05 M HNO_3. The preliminary laboratory outcomes affirm the great potential of MO seed & algae for wastewater pre-treatment applications. Other research must be investigated on the residue of MO seed powder to appraise its suitability as an alternative protein source for animal husbandry.
Keywords: El-Rahawy Drain; Moringa Oleifera, Natural Adsorbent; Wastewater treatment.

1. Introduction

Water shortage is one of the main issues all over the world in this century. Now, it is imperative to look for non-conventional sources of water such as agricultural drainage water to reduce the gap between water supply and demand. Recycling of drainage water affords Egypt the solutions to the detrimental impact of water shortage on its agricultural extension [1].

El-Rahawy drain is located between 30°10' N and 30°12' N and longitudes 31°2' E and 31°3'E, starting at El-Rahawy Pump station on Mansouria Rayah, 30 kilometres north of Cairo in the El- Kanater El-Khayria area, Egypt [2]. It covers an area of approximately 12.41 km^2 and passes through El-Rahway town and many villages distributed along it receiving agricultural and domestic wastes without treatment as well as sewage from El-Giza governorate and releasing these wastes without treatment straight forward into the Rosetta branch of the River Nile [2-3]. EL-Rahawy drainage wastewater travels approximately 4 kilometres through El-Rahawy village before entering the Rosetta branch [4].

Greener wastewater treatment processes seem to become increasingly popular because they are more environmentally friendly and provide a variety of other benefits, such as cost savings and reduced by-product (secondary product) generation. *Moringa Oleifera* (MO), in particular, has long been utilized as a chelating agent to remove harmful effluents in developing countries [5-6].

Natural coagulants derived from tropical plants of the *Moringaceae* family, which originated in India and

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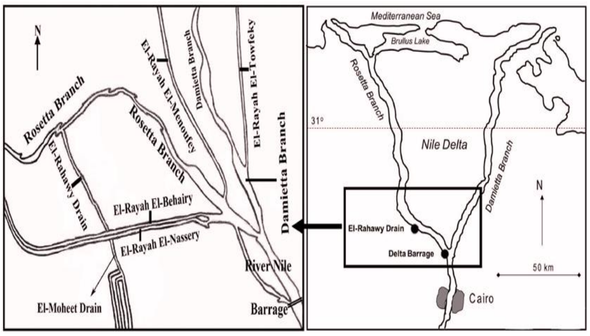
Sri Lanka and can be grown in Asia Minor and Africa, are of particular interest. MO leaves and seeds are the most commonly used in water treatment.



Map 1: Location of El-Rahawy drain on Rosetta branch.

It is highly suggested to use low-cost MO seeds as an eco-friendly, non-toxic, and simplified water treatment in rural and semi-urban areas where people live in extreme poverty [7]. MO seeds appear to be among the most effective primary water treatments [8, 9]. MO has no significant side effects when used in wastewater treatment because it is non-toxic and biodegradable [10-14].

MO, also called as the miracle tree, is a medium or small-sized tree. MO seeds are utilized in water and wastewater treatment because of the presence of water-soluble floc protein that binds and crosslinks suspended molecules in a colloidal structure, leading to the development of larger precipitated particles [15-16].

Previous research has found that various parts of the Moringa plant, including the roots, flowers, bark, and stem, as well as the seeds, have antimicrobial properties [17-20]. Microorganisms are appended directly to small particles in water samples, and Moringa seed particle treatment can eliminate over 90% of the microbial contamination [21].

According to Vieira et al. [22], MO seeds utilized as a natural sorbent have the greatest removal efficacy of 98% for both color and turbidity. Arnoldsson et al. [23] confirmed that MO seeds had no impact on pH of water, alkalinity, and conductivity.

MO seeds have been investigated for their ability to eliminate metal ions from aqueous solutions as well as their coagulating properties. Nand et al. [24] observed that MO was more capable to adsorb heavy metals than some other seed types. Copper was eliminated at a rate of 90%, lead at 80%, Cd (II) at 60%, and zinc and chromium at 50%.

Textile dye wastewater is one of the most difficult to treat [25] due to the complex aromatic compositions of synthetic dyes that are slightly biodegradable [26]. Acid Orange 7 dye is used to color a variety of fabrics including nylon, wool, and silk. It is typically disposed of in industrial effluents, as are other azo dyes. It is incredibly harmful and poses a serious health risk to humans [27].

The present work aims to assess El-Rahway drain water quality. On a laboratory scale, investigate the efficiency of Mo and MO-algae mixture for improving its water quality in order to meet the environmental legislations of Egypt was carried out. Different doses of MO were applied to dyes wastewater to determine the suitable dose of color removal.

32. Materials and Methods

2.1. Chemicals and Materials

In this investigation, pure analytical grade for chemicals and reagents were utilized. Solutions were prepared in Milli-Q water. *Moringa Oleifera* (MO) mature pods were purchased from Agricultural Research Center, Cairo- Egypt. The Acid Orange 7 was supplied by El-Saidy textile factory in industrial zone C1, Tenth of Ramadan City, El-Sharqyiah Governorate, Egypt. The structure and characteristic of Acid Orange 7 (AO7) used in this experimental work was displayed in Table 1.

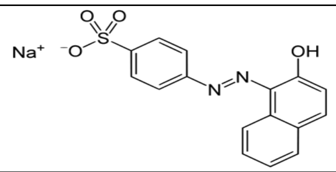
2.2. Sample collection

About 50 L composite wastewater samples were collected seasonally. The first site (R1) from El-Rahawy drain at El-Rahawy village – Giza governorate (highly contaminated). The second site (R2) from Rosetta branch at AlQanater Al-khairia (less contaminated). Samples were gathered in a polyethylene tanks and sent promptly to the "Central Laboratory for Environmental Quality Monitoring (CLEQM)"

2.3. Water quality assessment for the selected water bodies:

The Physico-chemical assessments of the collected water samples were determined according to the Standard Methods for the Examination of Water and Waste Water [28].

Table 1 Structural and characteristic of Acid Orange 7 (AO7)

Dye	class	Structural		λmax
Acid Orange 7 (AO7)	Single azo class	$C_{16}H_{11}N_2NaO_4S_7$ [p-(2-hydroxy-1-naphthylazo) benzene sulfonic acid		485 [27]

pH and electrical conductivity (EC) were measured in situ by using a Hydralab- Surveyor multi-probe. In Lab, the gravimetric method was utilized to measure the total dissolved solids (TDS). Total alkalinity (CO_3^{2-}&HCO_3) was measured using 0.02 N H_2SO_4. Major anions (chloride, nitrate, phosphate, and sulfate), as well as, Major cations (calcium, potassium, magnesium, and sodium) were determined using DX-500 Ion Chromatography (IC). Heavy metals were detected by the Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) model Perkin Elmer, NexION 300D.

The microbiological assessment was carried out according to [28], that was including; counting of the total viable bacteria at 35 ºC and 22ºC by pour plate method using plate count agar medium (Difco, USA). Enumeration of *total coliforms (TC)*, *fecal coliforms* (FC), and *fecal streptococci* (FS) by membrane filter technique using m-Endo agar LES medium (Biolife, Italy), m-FC agar medium (Merck, Germany), m-enterococcus agar medium, and MPAC agar medium (Difco, USA).

2.4. Plant sampling and seed extract preparation

Moringa Oleifera seeds (Fig. 1) suspension solution was prepared by a modified method of Doerr, 2005 [29]. Dry mature *Moringa Oleifera* seed pods were collected, the seeds were removed from the pods, and then the seed coat was removed to obtain a clean seed kernels, Fig. 1. The dried seeds were ground using porcelain mortar and sifted through a small mesh to obtain fine powder. MO seeds powder is kept at room temperature until use.

A weight of 0.09 g of MO powder was mixed with small amount of sterile distilled water to form a paste. The paste was soaked in 100 mL distilled water (DW) and shook for 1 minute to activate the coagulant properties and form a solution. This solution was filtered through a muslin cloth to remove insoluble materials (MO powder residue).

Fig. 1. Photos of raw and peeled *Moringa Oleifera* (MO) seeds.

2.5. Treatment of water samples

A specific volume of the *Moringa Oleifera* seeds water extract was added to 1 L of each wastewater sample. Thereafter, the suspension was mixed rapidly for one min, and then was mixed slowly for 10 min on a stirrer rotator rapidly (25 rpm) for at least 1 minute then slowly (10 rpm) for 5-10 minutes. The solution was kept without distribution for 24 hrs. The supernatant solution (treated water) was drawn from the surface and kept for complete analyses.

2.5.1. Impact of different parts of MO plant on wastewater:

Wastewater samples collected from El Rahway drain (R1) and River Nile (R2) were treated with different additions of *Moringa Oleifera* and algae as shown in Table 2. Where T1 and C1 samples are treated with 2 whole seeds, T2 and C2 samples are treated with 2 ground seeds, T3 and C3 samples are treated with 2 seeds and 0.5 algae, T4 and C4 samples are treated with 2 grounded seeds and 0.5 algae, T5 and C5 samples are treated with 20 mL *Moringa Oleifera* seeds extract, and T6 and C6 samples are treated by branches of *Moringa Oleifera*. The experiments were repeated thrice, and after that, all the samples before and after treatment was subjected to complete analyses (section 2.3).

2.5.2. Impact of different concentrations of *Moringa Oleifera* seeds water extract

Wastewater samples collected from El Rahway drain (R1) and River Nile (R2) were treated with different concentrations of *Moringa Oleifera* water extract as shown in Table 3 and Fig.2. Where R1and R2 represent wastewater and control samples, respectively, M1 and M4 represent samples treated with 30 mL *Moringa Oleifera* water extract, M2 and M5 represent samples treated with 50 mL *Moringa Oleifera* water extract while M3 and M6 represent samples treated with 70 mL *Moringa Oleifera* water extract. The experiments were repeated thrice, and after that, all the samples before and after treatment was subjected to complete analyses (section 2.3).

2.5.3. Impact of utilizing blue green algae as supplemented to MO seeds

Wastewater samples collected from El Rahway drain (R1) and River Nile (R2) were treated with different weights of algae at constant weight of *Moringa Oleifera* (MO) water extract as shown in Table 4. Where R1and R2 represent wastewater and control samples, respectively, A1 and A4 represent samples treated with 0.5g of algae + 70 mL *Moringa Oleifera* water extract, A2 and A5 represent samples treated with 1.5 g of algae + 70 mL *Moringa Oleifera* water extract while A3 and A6 represent samples treated with 3 g of algae + 70 mL *Moringa Oleifera* water extract. The experiments were repeated thrice, and after that, all the samples before and after treatment was subjected to complete analyses (section 2.3).

Fig.2. Different concentrations of *Moringa Oleifera* extract applied wastewater samples collected from El Rahway drain (R1).

2.5.4. Removal of Acid Orange 7 dye from wastewater by natural adsorbent of *MO* Seeds:

Stock solution (500 mg/L) was prepared by dissolving 0.05 g of Acid Orange 7 in 10 mL of distilled water and diluting quantitatively to 100 mL. *Moringa Oleifera* seeds suspension was prepared by according to a modified method of Veeramalini et al., 2012 [30]. Four gram of *Moringa Oleifera* seeds was added to 100 mL of sodium chloride (NaCl) salt solution to extract the active component coagulant, then stirred for 30 min at room temperature using a magnetic stirrer to create active constituents to prepare a stoke solution of 4% W/v., and filtered through Whitman filter paper. The produced filtrate solution was used as a coagulant. A fresh solution was prepared every day for reliable results.

All coagulation experiments were carried out in the 100 ml transparent bottles, and the samples were left undisturbed on a flat surface for 72 h to allow for the complete settlement of MOS and the large to remove Orange 7 dye aggregates. The effects of different weights of MO on Orange 7 dye coagulation were investigated.

To check the efficiency of *Moringa Oleifera* seeds extract to remove Orange 7 dye from wastewater, a laboratory-scale experiment was set up. The experiment was carried out at room temperature (30°C) and pH of7 by varying the amount of *Moringa Oleifera* (MO) *seed* extract. Different concentrations of MO seed salt (100, 200, 300, 400, and 500 mg/L) were applied to 50 mg/L dye wastewater. The samples were kept for sedimentation for 24h. After sedimentation, the supernatant was separated by filter paper, after which the filtrate was investigated utilizing a UV spectrophotometer at a wavelength (λ) 485 nm. The readings were estimated in triplicate for each solution to check the repeatability. The readings were recorded before and after exposure to MO extracts. The MO removal efficiency was estimated by the following equation, where DCi and DCf are the initial and final concentrations of the dye.

$$\text{Removal efficiency }(\%) = \left[\frac{(DCi - DCf)}{DCi}\right] \times 100$$

Table 2 Dose of *Moringa Oleifera* (MO) and algae utilized for treatment wastewater (R1& R2) samples collected from El Rahway drain.

Item	Code	Description	Item	Code	Description
Wastewater from El-Rahawy Drain (R1)			*River Nile Water (R2)*		
1	T1	R1 + 2 whole seeds	1	C1	R2 + 2 whole seeds
2	T2	R1 + 2 grounded seeds	2	C2	R2 + 2 grounded seeds
3	T3	R1 + 2 seeds + 0.5 g algae	3	C3	R2 + 2 seeds + 0.5 g algae
4	T4	R1 + 2 grounded seed + 0.5	4	C4	R2 + 2 grounded seed + 0.5
5	T5	R1 + 20 mL MO extract	5	C5	R2 + 20 ml MO extract
6	T6	R1 + branches of MO	6	C6	R2 + branches of MO

Table 3 Different concentrations of *Moringa Oleifera* water extract utilized for treatment wastewater (R1& R2) samples collected from El Rahway drain.

Item	Code	Description	Item	Code	Description
Wastewater from El-Rahawy Drain (R1)			*River Nile Water (R2)*		
1	R1	R1	1	R2	R2
2	M1	R1 + 30 mL *Moringa Oleifera* extract	2	M4	R2 + 30 mL *Moringa Oleifera* extract
3	M2	R1 + 50 mL *Moringa Oleifera* extract	3	M5	R2 + 50 mL *Moringa Oleifera* extract
4	M3	R1 + 70 mL *Moringa Oleifera* extract	4	M6	R2 + 70 mL *Moringa Oleifera* extract

Table 4 Different weights of algae at constant volume Mo*ringa Oleifera* water extract utilized for treatment wastewater (R1& R2) samples collected from El Rahway drain.

Item	Code	Description	Item	Code	Description
Wastewater from El-Rahawy Drain (R1)			*River Nile Water (R2)*		
1	R1	R1	1	R2	R2
2	A1	R1 + 70 mL MO + 0.5 g algae	2	A4	R2 + 70 mL MO + 0.5 g algae
3	A2	R1 + 70 mL MO + 1.5 g algae	3	A5	R2 + 70 mL MO + 1.5 g algae
4	A3	R1 + 70 mL MO + 3 g algae	4	A6	R2 + 70 mL MO + 3 g algae

2.8. Desorption or recovery Experiment

Desorption studies were conducted to restore the sorbent pollutants as a function of concentration 0.05 M HCl and 0.05 M HNO_3. The contaminants-loaded MO & Algae obtained from our sorption experiments was transferred to Erlenmeyer flask and shaken with 50 ml of each acid for 40 min. The filtrate was analysed for desorbed Physico-chemical parameters. After that the regenerated algae was mixted with 70 mL of MO seed extract to investigate their efficiency of removal of contaminant from wastewater.

2.9. Statistical analyses

Each experiment was repeated thrice. Min, Max, mean values, standard deviation (SD), and relative standard deviation (RSD) were estimated utilizing statistical software SPSS, V 15, 2006.

3. Results and Discussion

3.1. Water Quality Characteristics

The results of the physicochemical characteristics of the collected water samples are illustrated in Table 5. It was clear that El-Rahawy drain water contained more organic contaminants than the Nile River water, as indicated by high values of BOD, COD, and TOC and low values of DO for the former. In addition, El-Rahawy drain water was also contaminated with some heavy metals like Al, Cu, Fe, Mn, Ni, and Zn. Wastewater samples from the El-Rahawy drain was containing elevated numbers of *fecal* coliforms and total coliforms than Nile River water. The outcomes of the present study indicated that the wastewater contains DO, BOD, COD and TOC concentrations violating the limits of Egyptian standards. Furthermore, the authors investigated the efficacy of *Moringa Oleifera* and algae to reduce these pollutants from wastewater. Different doses from algae and *Moringa Oleifera* were applied to wastewater collected from El Rahway drain (R1), and River Nile (R2).

Table 5 Characteristics of water samples collected from El Rahawy drain (R1) and River Nile (R2).

Parameters	R1	R2	Parameters	R1	R2
pH	7.45±0.66	7.99±0.65	Fluoride F^-	0.23±0.02	0.29±0.02
Total Alkalinity	380±32.25	221.5±17.2	Chloride Cl^-	171.91±14.0	18.2±1.54
Electrical Conductivity EC	1.25±0.11	0.403±0.03	Nitrite NO_2^-	<0.2	<0.2
Total Dissolved Solids TDS	795±65.9	258±20.1	Nitrate NO_3^-	<0.2	0.55±0.035
Dissolved oxygen DO	0.1±0.01	4.21±0.33	Turbidity (NTU)	22.7±1.92	10.6±0.95
Biological Oxygen Demand BOD	130±10.41	12±0.99	Phosphate PO_4^{3-}	2.87±0.25	<0.2
Chemical Oxygen Demand COD	170±14.62	8±0.68	Sulfate SO_4^{2-}	87.46±7.52	41.1±3.32
Total Organic Carbone TOC	43±3.67	5.2±0.40	Ammonia	19±1.54	<0.01
Oil and Grease	1.11±0.1	0.15±0.01	Aluminum Al^{3+}	0.049±0.004	0.007±0.001
Calcium Ca^{2+}	53.25±4.7	39.13±2.95	Barium Ba^{2+}	0.040±0.003	0.035±0.002
Potassium K^+	15±1.31	5±0.38	Copper Cu^{2+}	0.068±0.005	0.017±0.001
Magnesium Mg^{2+}	28.4±2.47	18.85±1.45	Iron Fe^{2+}	0.153±0.011	0.027±0.002
Sodium Na^+	160±13.95	31±2.24	Manganese Mn^{2+}	0.163±0.010	0.063±0.005
Faecal coliform FC	$130 \times 10^4 \pm 11 \times 10^3$	$35 \times 10^2 \pm 2 \times 10^2$	Total coliforms TC	$210 \times 10^4 \pm 18 \times 10^3$	$59 \times 10^2 \pm 4 \times 10^2$

The units of parameters in Table 5 are mg/L, except pH is unitless, and total *coliforms* & *fecal coliforms* are CFU/100mL. Data represented as mean ± SD of 3 samples.

3.2. Treatment of water samples

3.2.1. Impact of different parts of *Moringa Oleifera* plant in wastewater treatment

There is no observed change in the physico-chemical characteristics and microbial status for wastewater sample from El Rahawy drain (R1) while the River Nile sample (R2) showed slight decreasing in microbial status with 20 mL of *Moringa Oleifera* extract. Whereas, the removal efficiency for FC, and TC from R2 was 7%, and 18%, respectively.

3.2.2. Impact of different concentrations of *Moringa Oleifera* seeds water extract

Fig. 3 showed the impact of different MO concentrations on the removal efficiency (%) of wastewater pollutants. The results indicated that there is a gradual decrease in some parameters of physicochemical and microbiological characteristics of the treated water samples with increasing concentration of *Moringa Oleifera* water seed extract. Upon treatment with 70 ml of MO seeds coagulant, a significant decrease in turbidity values was observed at 80% for R1 (wastewater) and 92% for R2 (River Nile) samples, respectively. MO treatment of R1 and R2 samples revealed an increase in DO value by about 52-58% from the original DO value this may be due to the decrease in bacterial population that was caused by MO. Also, MO treatment caused an obvious increase in the BOD, and COD reflected a decrease in the bacterial population caused by MO antimicrobial activity. The COD concentration was increased by increasing the concentration of *Moringa Oleifera* seeds extract which might be attributed to the rich seeds by nutrients. MO treatment caused a reduction of Cd, Pb, Mn, Al, and Co ions by about 78, 90, 99, and 98%, respectively with 70 ml of *Moringa Oleifera* seeds extract. Con. 70 ml of Mo extract caused the removal of total coliform by 52% and 80%, while *fecal* coliform removal was 69% and 90% for R1 and R2 samples, respectively.

3.2.3. Studying the efficacy of using algae as supplemented to MO seeds extract in the treatment of wastewater:

Physicochemical and microbiological characteristics of the collected water samples treated showed some decrease with increasing concentration of alga as supplementation to concentration 70 ml of *Moringa extract*. Using 3 g of alga with 70 ml of MO seeds coagulant a significant decrease in turbidity values was observed with a removal efficacy of 74%, and 89% for wastewater and river Nile, respectively, with a significant increase in DO value in the treated water samples.

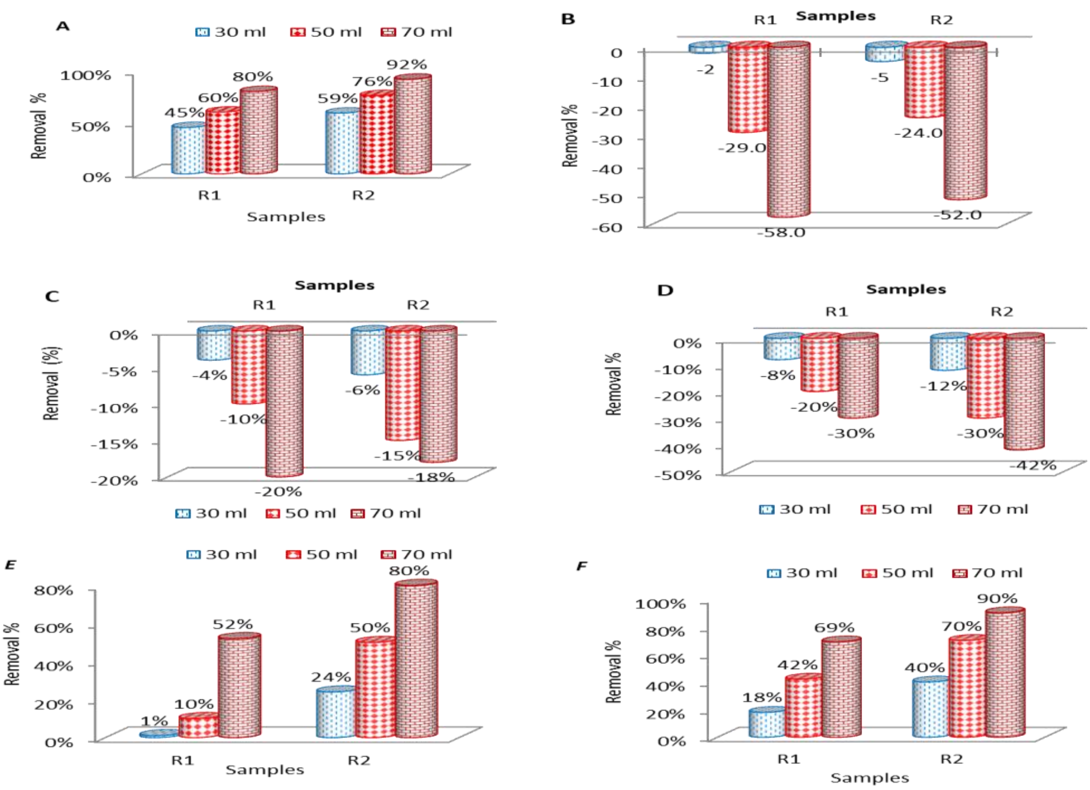


Fig.3. Removal efficiency (%) by using different *Moringa Oleifera* (MO) water seeds extract concentrations for the treatment of wastewater (R1) and control sample (R2) by Moringa Oleifera water seeds extract (a) turbidity (b) DO, (c) BOD (d) COD (e) total coliform (f) *fecal* coliform.

Combined Alga and MO treatment caused a reduction in the BOD by 79% and 95% for R1 and R2 respectively. Decrease of COD by increasing amount of algae add than the previous experience which might be attributed to that the algae produce toxins of long chain fatty acids which kill pathogens [31]. Using 3 g of algae with a concentration of 70 ml of MO extract caused total viable bacterial counts (CFU) removal was 63%, and 90% at 22ºC and 67%, and 92% at 35ºC, while *fecal* coliform removal was 72% and 93 %, and *fecal* streptococci removal was 59%, and 77% for wastewater and river Nile samples, respectively. The higher removals are owed to the nutrient competition of algae with coliform bacteria and also aeration (addition of O_2 by algae) enhances *fecal* coliform die-off rates [31].

3.2.4. Removal of Acid Orange 7 dye from wastewater used by MO Seeds:

Coagulants modify the surface charge properties of solids to permit particles to agglomerate or stick together in a flocculent precipitate. Coagulation and flocculation of suspended particles and colloids are caused by various mechanisms including electrostatic attraction (reduction of the repulsive potential of electrical double layers of colloids), sorption (related to protonated amine groups), bridging (related to polymer high molecular weight). In some cases, the amount of protonated amine groups added to the solution is far below the number of charges necessary for the neutralization of the anionic charges held by the colloids; the removal of particles can be explained in this case.

This study showed an increase in decolonization by increasing the dose of MO seeds extract as presented in Figs. 5-6. It was found that the optimal concentration of 400 mg showed a high ability to remove 80% of Orange 7 dye after 24 h. In accordance with what was achieved in the present study, a study recorded by Farooq et al. [32] reported that *Moringa* extract caused the removal of about 95% of Blue dye, Crimson, and Navy dyes.

3.3. Recovery or desorption studies:

The extraction process of MO residue was repeated on it for ten cycles. The treatment was done with this extract as well as adding it to the algae powder to repeat the treatment process. The results showed the efficiency of the extract for abatement investigated until the fifth time, and the efficacy of removal began to decrease gradually by 5-20%.

Desorption of metal ions from exhausted algae mixed extract of MO seed powder has also been attempted two different acids 0.05 M HCl, and HNO_3. The maximum desorption observed by 0.05M HCl was 90-91% for TSS, and heavy metals. However, HNO_3 provided better desorption of 98-98.6% for TSS, and heavy metals could be achieved with 0.05M HNO_3. The sorption studies were repeated after regeneration of sorbent material for the investigated physico-chemicals parameters and it is interesting to note that the sorption remains approximately the same with four regeneration steps.

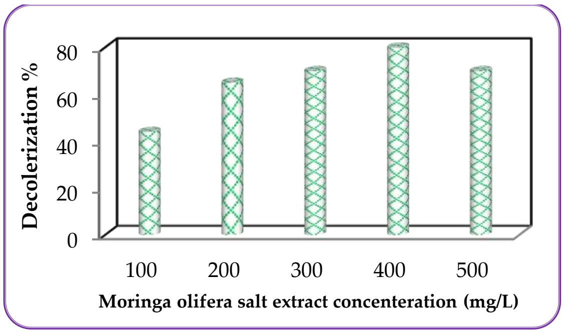


Fig.5. Efficiency of different Moringa extract with 5% of orange 7 dyes.

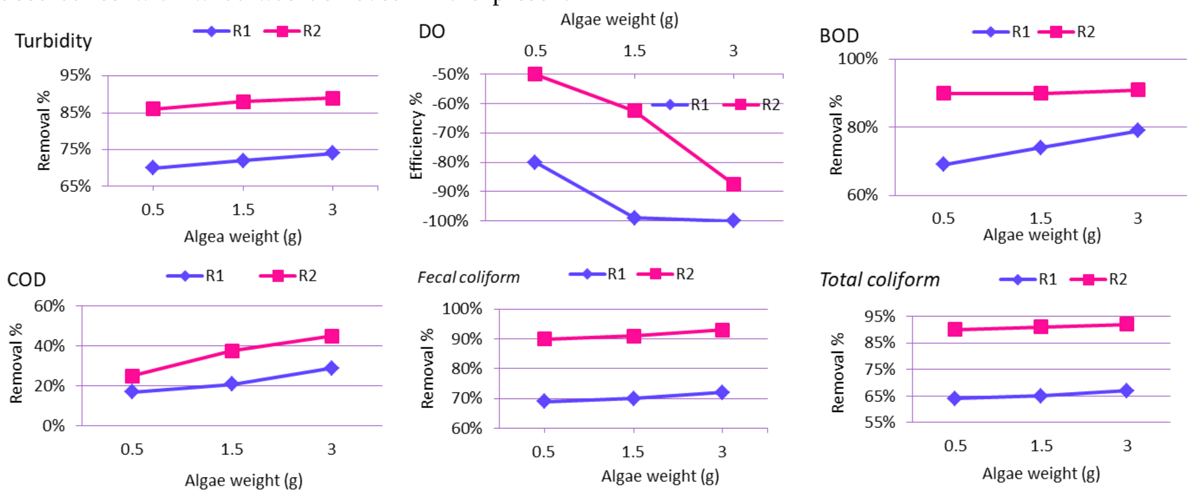


Fig.4. Removal percentage for turbidity, DO, BOD, COD, total coliform, and fecal coliform by using different concentrations of algae as supplemented to Moringa Oleifera water seeds extract.

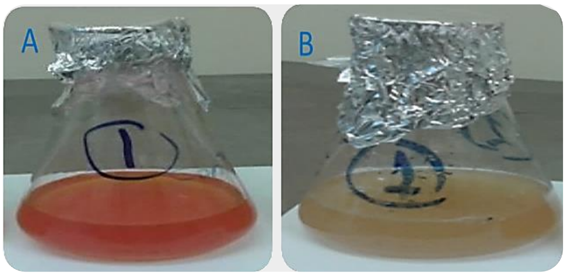


Fig.6. (A): orange dye wastewater, while (B): water after 7days of addition MO extract.

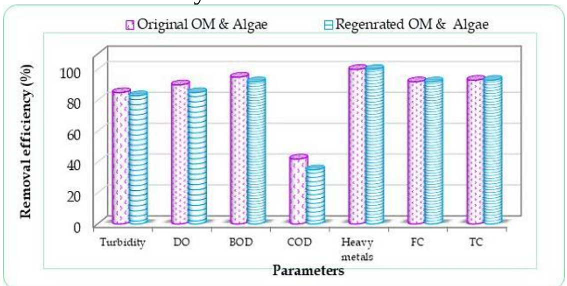


Fig.7. Removal percentage for turbidity, DO, BOD, COD, total coliform (TC), and fecal coliform (FC) by original and regenerated algae &OM.

4. Conclusion

The outcome indicated the ability of MO seed to mitigate the pollutant of wastewater, while the plant of MO couldn't able. In the present study, 90 to 99% of water impurities and reduce about 90% of the total bacterial load of surface water with a slight change in the Physico-chemical characteristics of the collected water samples were done with *Moringa Oleifera*. The addition of Algae to *Oleifera* enhances its removal efficiency for water impurities. The mixing between Moringa Oleifera seeds and algae represents an indigenous pre-remediation technology of wastewater pollutants. Also, Moringa Oleifera extract showed its ability as a coagulant solution for the removal of dyes from wastewater with an optimal dose of 400 mg/L to decolorize 5% of orange 7 dyes. The exhausted materials can be recovered by 0.05 M HNO_3 and then successfully reused in the treatment by addition 70 mL from extracted MO seed. The treatment solution can be extracted from MO seed powder for five repetitions without any impact on the treatment efficiency.

This study suggests that more research should be done on the residue of MO seed powder to determine its suitability as an alternative protein source for animal husbandry.

5. Acknowledgements

The authors are most appreciative to the working staff for their valuable cooperation.

6. Conflicts of interest

The authors declare no conflict of interest.

7. Reference

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