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Treatment of Nile River water using *Moringa oleifera* seed extract in El-Sharkia Governorate, Egypt

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Abstract

Water treatment in Egypt's El-Sharkia governorate is the focus of this investigation. There are more questions about the long-term safety of the ecosystem and human health when using conventional water purifying technologies. Traditional techniques employ aluminium sulphate (alum) as a water coagulant. Alzheimer's disease and other neuropathological illnesses have been linked to aluminium in several studies. Plant-based coagulants like M. oleifera are environmentally safe, non-toxic, and the most promising and cost-effective solution for water treatment. The seed extract of M. oleifera is used as a water coagulant in the new water treatment technology. Using the Jar test, alum and M. oleifera are compared as coagulant agents. The Belbeis Water Treatment Station collects the water samples throughout the course of a year, in all four seasons (2019-2020). For both raw and treated water, the evaluation of physicochemical and microbiological characteristics was conducted. More importantly, iron and manganese concentrations were reduced as well as overall bacterial population. Using M. oleifera as a biocoagulant for water purification is recommended by real testing.

Keywords: Water purification, Aluminum sulphate, Alum, Traditional coagulant, *Moringa oleifera*, Biocoagulant.

1. Introduction

In Egypt, where the Nile River is the primary supply of fresh water, water demand has skyrocketed in the past few years. The Nile's Egyptian share is set at 55.5 billion metric tonnes per year. As a result of the Grand Ethiopian Renaissance Dam (GERDdevelopment,)'s Egypt's government is working hard to ensure that its yearly water supply from the Nile River is not affected [13].

Because water is essential to all living things, including microbes, ensuring the availability of clean and safe drinkable water is a global priority. The elimination of turbidity is a critical stage in the treatment of surface or ground water in order to produce drinkable water [16].

There are 783 million people in the globe who do not have access to improved drinkable water, and the WHO estimates that this leads to 1.6 million deaths per year due to diarrheal and parasitic illnesses. Traditional water treatment comprises coagulation, flocculation, sedimentation, filtration and disinfection [2].

In order to measure the quality of drinking water, physical, chemical, and biological characteristics are often used to evaluate it. As turbidity rises, harmful organisms may spread through it, hence removing turbidity from water is a critical step in water treatment [19].

To remove turbidity in rural and developing areas, simple and inexpensive techniques like coagulation are often used; coagulation is typically performed by adding standard chemicals like aluminium and ferric salts to the water supply [14]. In addition to the harmful sludge volume generated by these chemical coagulants, aluminium has previously been linked to neurological disorders [19]. In addition, the chlorination process used to disinfect water in many poor countries might lead to many by-products with long-term negative consequences. Natural coagulants from plants are being used to address these issues since they are often less toxic and caustic than their chemical equivalents [6].

Overdosing on aluminium sulphate (alum) in a water treatment process may lead to an increase in aluminium content in potable water, which is the most often used water coagulant. The turbidity of the water is increased due to the remaining aluminium, which may be harmful to human health. It's possible, according to many studies, that aluminium is linked to neuropathological disorders including presenile dementia and Alzheimer's disease, among others. Other than that, acidic water that is produced as a byproduct is harmful to pregnant women and has been linked to dementia in certain cases [12].

In addition to being environmentally friendly and cost-effective, natural coagulants are also nontoxic. Decrease sludge volume by increasing floc size, which has qualities like long-chain polymer, high cationic charge density, high biodegradability and eco-friendly. [21].

An average height of 10 to 12 m, M. oleifera, drumstick is a tropical plant from the Moringaceae family, which is widely farmed in the desert regions of the world. Using the dried seeds of M. oleifera as a natural coagulant to treat effluent and turbid water is effective. Trees of M. oleifera's medium size and several uses may be found all throughout Asia, South America, and Africa, although they are most often found in northwest India [21].

Organic contaminants and pesticides may also be removed from contaminated water using M. oleifera seeds. Chemical coagulants create more sludge than M. oleifera seeds [12].

M. oleifera seed extract's practical efficacy in water treatment is examined in this research. Seed features and coagulant activity in favour of chosen water quality criteria were clearly shown by the correct use of the Jar test.

2. Materials and methods

2.1. Source

In order to study seasonal fluctuations in microbiological, physical, and chemical parameters, water samples were collected from Belbeis over the course of a year (2019-2020). Ismailia Canal runs through Belbeis station.

2.2. Collection of water samples

For four seasons, Belbeis drinking water treatment station gathered sixteen samples of water. One alum-treated sample, another M. oleifera seed extract-treated sample, and two additional samples for physicochemical and microbiological studies were obtained for each season. According to the American Public Health Association, the sets were delivered in cold cartons to the laboratory within 30 minutes.

2.3. Plant sample

From the Agriculture Research Center came dried M. oleifera seeds.

2.4. Preparation of the crude extract of *M. oleifera* seed

A mortar and pestle was used to grind the seed kernels into a fine powder once the outer shell was removed. The seed powder was dissolved in 100 cc of tap water and stirred for three minutes before being used. After 10 minutes of stirring, Whatman No.1 filter paper was used to remove the solids from the solution. The final stock solution had a concentration of around 3%. (12). It was made by dissolving 1 gramme of aluminium sulphate powder in 100ml of tap water and then diluting the solution. Each day's experimental stock solutions were made fresh to prevent the effects of ageing.

2.5. Treatment of water samples (Coagulation assay)

The following steps are taken **[10]**.

- Jar test is performed to find ideal dose of alum (chemical coagulant) and *M. oleifera* extract (natural coagulant).
- 1000 ml of river water (an input water source for the company) were put into the beakers of the apparatus.
- Then the six prepared concentrations of each coagulant (60, 90, 120, 150, 180 and 210 mg/l) of the *Moringa* seed extract and (13, 15, 17, 19, 21 and 23 mg/l) of the alum to were added to the six beakers present in the apparatus.
- Paddles are fixed at 240 rpm and solution in the beakers can rapidly mix for 1 minute.
- After rapid mixing, change the mixing speed to 40 rpm for 20 minutes for slow mixing.
- After slow mixing, the paddles were removed to permit solids to settle for 30 minutes until water is cleared.
- the very top part of the sample was taken from each jar to measure turbidity, iron, manganese and total bacterial count and record the results.

2.6. Water analyses procedure

Analysis of water samples is carried out according to Standard Methods for Examination of Water and Wastewater **[3]**.

2.7. Bacteriological analyses

Total bacterial counts were determined by poured plate method. Two sets of duplicate plates were used for each sample dilution. One set of inoculated plates were incubated at 35ºC for 24 hours and the other set for two days at 22°C.

The developed colonies were counted and the bacterial number determined as CFU/ml for each water sample.

2.8. Physical and chemical analyses of water samples:

Turbidity, iron and manganese concentrations were carried out according to Standard Methods for Examination of Water and Waste Water**(3)** .

The turbidity of samples is determined by HACH – Germany / TL2300 turbidity meter.

Iron and manganese concentrations were detected using spectrophotometer at 510 and 525 nm respectively.

3. Results

3.1. Effect of Treatment of *M. oleifera* and alum on turbidity during the four seasons.

The results in Table 1 and Table 2 explained that, the treatment with M. oleifera seeds extract decrease turbidity values from10.3 (for raw water) to 1.6 NTU during January, from (8.16 to 1.8) NTU during April, from (14.42 to 1.66) NTU during July and from (16.4 to 2.2) NTU during October. However, the treatment with alum decrease turbidity values from 10.3 (for raw water) to 1.44 NTU during January, from (8.16 to 1.4) NTU during April, from (14.42 to 1.12) NTU during July and from (16.4 to 0.99) NTU during October.

Also with increasing the concentration of M. oleifera and alum there were decrease in turbidity to certain concentration followed by gradually increase concentration.

Table (1) Effect of seasonal variation on Turbidity (NTU) of raw, *M. oleifera* treated water of Belbies station.

Season	Raw water (NTU)	*Moringa* Conc (mg/l)					
		60	90	120	150	180	210
January	10.3	3.6	2.9	1.9	1.6	1.7	1.9
April	8.16	3.3	2.7	2.65	2.2	1.8	2.1
July	14.42	3.86	3.25	2.92	2.13	1.66	1.85
October	16.4	3.62	3.45	2.8	2.6	2.2	2.5

Table (2) Effect of seasonal variation on turbidity of raw, alum treated water of Belbies station.

Season	Raw water (NTU)	alum Conc(mg/l)					
		13	15	17	19	21	23
January	10.3	2.24	1.81	1.44	1.46	1.5	1.62
April	8.16	2.24	1.81	1.52	1.4	1.52	1.62
July	14.42	2.25	1.74	1.53	1.12	1.23	1.21
October	16.4	1.99	1.61	1.2	0.99	1	1.1

3.2. Effect of Treatment of *M. oleifera* and alum on iron during four seasons.

Iron of examined water samples during period (2019- 2020) are presented in **al Standard** for Drinking Water.

Table (3 and **ND=**not dtected

Table 4 having range between ND (not detected) for many treated samples and 0.56 mg/l (raw water of Belbies station). The treatment with *Moringa* seeds extract decreased iron values from 0.5 mg/l (for raw water) to ND during January, from (0.56 mg/l to ND) during April, from (0.52 mg/l to ND) during July and from (0.46 mg/l to ND) during October. On the other hand, treatment with alum decreased iron values from 0.5 mg/l (for raw water) to ND (not detected) during January, from (0.56 mg/l to ND) during April, from (0.52 mg/l to ND) during July and from (0.46 mg/l to ND) during October.

Generally, treatments with *M. oleifera* and alum decreased iron to be less than maximum permissible measure (0.3 mg/L) of National Standard for Drinking Water.

Table (3) Effect of seasonal variation on iron of raw, *M. oleifera* treated water of Belbies station.

Season	Raw water(mg/l)	*Moringa* Conc (mg/l)					
		60	90	120	150	180	210
January	0.5	0.09	0.07	0.05	0.02	ND	ND
April	0.56	0.1	0.09	0.03	0.01	ND	ND
July	0.52	0.12	0.08	0.04	0.01	ND	ND
October	0.46	0.11	0.09	0.04	0.01	ND	ND

ND=not dtected

Table 4 Effect of seasonal variation on iron of raw, alum and alum treated water of Belbies station.

Season	Raw water(mg/l)	Alum conc (mg/l)					
		13	15	17	19	21	23
January	0.5	0.1	0.08	0.07	0.04	ND	ND
April	0.56	0.1	0.09	0.06	ND	ND	ND
July	0.52	0.18	0.11	0.08	0.04	0.01	ND
October	0.46	0.09	0.02	ND	ND	ND	ND

3.3Effect of treatment of *M. oleifera* and alum on manganese during four seasons.

Manganese of examined water samples during period (2019- 2020) are presented in Table **(5** and

Table (6 having range between ND (for many treated samples) and 0.23 mg/l (raw water of Belbies station). The treatment with *Moringa* seeds extract decrease manganese values from 0.14 mg/l (for raw water) to ND (not detected) during January, from (0.16 mg/l to ND) during April, from (0.19 mg/l to ND) during July and from (0.23 mg/l to ND) during October. On the other hand, treatment with alum decrease manganese values from 0.14 mg/l (for raw water) to ND (not detected) during January, from (0.16 mg/l to ND) during April, from (0.19 mg/l to ND) during July and from (0.23 mg/l to ND) during October.

Generally, treatments with *M. oleifera* and alum decreased manganese to be less than maximum permissible measure (0.4 mg/L) of National Standard for Drinking Water.

Table (5) Effect of seasonal variation on manganese of surface, *M. oleifera* treated water of Belbies station.

Season	Raw water(mg/l)	*Moringa* Conc (mg/l)					
		60	90	120	150	180	210
January	0.14	0.05	0.02	ND	ND	ND	ND
April	0.16	0.03	ND	ND	ND	ND	ND
July	0.19	0.03	0.01	ND	ND	ND	ND
October	0.23	0.02	ND	ND	ND	ND	ND

Table (6) Effect of seasonal variation on manganese of raw, alum treated water of Belbies station.

Season	Raw water(mg/l)	alum conc (mg/l)					
		13	15	17	19	21	23
January	0.14	ND	ND	ND	ND	ND	ND
April	0.16	ND	ND	ND	ND	ND	ND
July	0.19	0.06	0.03	ND	ND	ND	ND
October	0.23	0.01	ND	ND	ND	ND	ND

3.4 Effect of Treatment of *M. oleifera* and alum on total bacterial counts (CFU/ ml) during
3.5 four seasons.

Total bacterial counts is used to indicate the microbial status of water samples. The number of bacteria in different water samples growing at 22°C & 35°C were determined. Results in

Table (7, Table (8, Table (9 and **Table (10** indicated that, generally total CFU s at 22°C were higher than those at 35°C in raw surface water of both stations.

The results in **Table (9** and **Table (10** indicated that ,the total number of bacteria at 22°C ranged from (41000 to 22000), (94 to 137) and (3 to 38) CFU/ml in surface water, treatment with *M. oleifera* and treatment with alum respectively for 22°C populations The results in Table 7 and Table 8 indicated that, the total number of bacteria at 35°C ranged from (11000 to 21000), (83 to 130) and (2 to 19) CFU/ml in surface water, treatment with M. oleifera and treatment with alum respectively for 35°C populations

Table (7) Effect of seasonal variation on Total bacterial counts (CFU/ ml) at 22°C of surface, *Moringa* treated water of Belbies station.

Season	Raw water (CFU/ ml)	*Moringa* conc (mg/l)					
		60	90	120	150	180	210
January	22000	133	123	119	110	112	111
April	27000	118	110	102	100	100	98
July	41000	137	130	130	132	131	130
October	27000	118	108	94	98	95	95

Table (8) Effect of seasonal variation on total bacterial counts (CFU/ ml) at 22°C of surface, alum treated water of Belbies station.

Season	Raw water (CFU/ ml)	Alum conc (mg/l)					
		13	15	17	19	21	23
January	22000	38	11	4	3	4	3
April	27000	33	15	5	6	4	6
July	41000	26	10	3	4	5	3
October	27000	28	14	6	5	5	4

Table (9) Effect of seasonal variation on total bacterial counts (CFU/ ml) at 35°C of surface, *M. oleifera* treated water of Belbies station.

Season	Raw water (CFU/ ml)	*Moringa* conc(mg/l					
		60	90	120	150	180	210
January	11000	115	125	130	117	118	115
April	18000	94	90	88	90	94	100
July	21000	118	110	92	99	98	100
October	18000	102	92	86	83	90	94

Table (10) Effect of seasonal variation on total bacterial counts (CFU/ ml) at 35°C of surface, alum treated water of Belbies station.

Season	Raw water (CFU/ ml)	Alum conc (mg/l)					
		13	15	17	19	21	23
January	11000	19	10	5	6	4	2
April	18000	19	8	3	2	3	3

July	21000	13	7	3	2	3	4
October	18000	17	10	7	4	6	6

4. Discussion

An assessment of the effectiveness of M. oleifera seed extract as a coagulant and the treatment performance of M. oleifera seed extract on microbial reduction in raw water from Belbies were the two complimentary features of this research (2019-2020).

M. oleifera seed extract greatly lowers the turbidity of raw water compared to treated water, according to the results.

M. oleifera seed extract was tested at 60, 90, 120, 150, 180, and 210 mg/l concentrations.

Boulaadjoul et alfindings .'s were in accord with the results of the current research [4]. With higher dosages of M. oleifera seed extract, they discovered that turbidity reduction became more effective. For a 150 mg/l dose of M. oleifera, turbidity reduction achieved a high of 96%. (turbidity reduced from 1739 NTU to 69.01NTU).

Adsorption and charge neutralisation, or interparticle bridging, are the mechanisms by which the M. oleifera seed extract coagulates, according to Kansal and Kumari [8]. This allows for efficient precipitation out of solution. Water-soluble proteins with a net positive charge may be obtained by combining M. oleifera seed powder with water before using it in the recipe at hand. Polyelectrolytes in the solution bind negatively charged colloidal particles (clay, silt, bacteria, etc.) that cause raw water to become cloudy [7].

Treatment with Moringa seeds also reduced iron levels from 0.5, 0.56, 0.52 and 0.46 mg/l for surface water at Belbies station in January, April, July and October to ND (not detected) for each of those four months.

These findings are in line with recent research by Mohammed et al [12]. Iron removal was shown to be more efficient when treated with varied amounts of MOSE (M. oleifera seed extract). By an average of 91 percent, seed extract reduces iron (Fe). Metals are adsorbed onto the surface of Moringa seed sorbents, which removes heavy metals (iron and manganese) from samples.

Moringa seeds also reduced manganese (Mn) concentrations from 0.14 to ND (not detected) in the raw water of Belbies station throughout all four months of the year when treated with Moringa seeds.

The outcomes corroborated Lea's predictions [9].

Adding M. oleifera reduced the Mn concentration from 6 ppm to undetectable levels, he discovered. If Moringa amphoteric protein combines with metal ions binding substances that have an oppositely charged charge, this might cause reduced amounts of these metal ions to precipitate as insoluble metal hydroxides owing to the discharge of OH groups from M. oleifera [5].

Carboxylate and amino groups in the seeds of M. oleifera might be used to remove heavy metals from the environment, according to Soumaoro and colleagues [18]. The adsorption surfaces are the only place M. oleifera can grow. M. oleifera is a low molecular weight, short-chain cationic polyelectrolyte.

Moreover, the elimination of flocs during the coagulation process reduces the microbial population [20]

It also reduces the total coliform counts in treated water by 58.18% at 60 mg/l, according to the EPA. This might be because settling flocs trap bacteria. However, the decrease in coliforms in aluminium sulfate-treated water might be due to low pH, which can negatively impact microbial development as a consequence [11].

These plant proteins are widely distributed in nature, and their antimicrobial activity is primarily mediated via their contact with the target membrane, followed by membrane permeabilization and rupture, as [15] stated. Researchers A Othman and M Haroon [1] found that compared to other seasons, total bacteria growth at temperatures of 20 and 35 degrees Celsius was highest in the fall and lowest in the winter (with CFU ml-1 levels reaching as high as 105 CFU).

Because of their long-chain polymer, high cationic charge density, non-toxic, high biodegradability, and eco-friendly properties, these natural coagulants reduce sludge volume by increasing the floc size [21].

5. Conclusion

M. oleifera seeds were shown to be more successful than alum in treating raw water, according to a study published in the Journal of Agricultural and Food Chemistry. In addition to being inexpensive, M. oleifera seeds are natural, effective, and easily accessible. In this way, M. oleifera seeds behave as polyelectrolytes, which help to reduce turbidity through both sorption and inter-particle bridge formation. It's also a natural antibacterial agent, reducing the amount of germs in the water by attacking the microorganisms already there. Seeds from the M. oleifera plant are more effective in removing iron and manganese. An effective coagulant for the treatment of cloudy water is a local Moringa seed.

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