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Evaluation of *Moringa oleifera* in a Semi-Pilot System for the Removal of Bacteria and Algae from Water

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CURRENT approaches focus on sustainable water treatment systems that are of low cost, robust and that require minimal maintenance and operation skills. Locally available materials can be exploited towards achieving sustainable safe potable water supply. *Moringa oleifera* can offer an alternative option to synthetic coagulants. In semi-pilot system trials the results demonstrated the effect of flow rate of water on the effectiveness of *M. oleifera* seed extract as coagulant. The data showed that the clarification efficiency of *Moringa* seed extract at flow rate 0.1 l/sec was more than that at the flow rate 0.15 l/sec. Also, the results showed that the different algal group were more liable to removal treatment with *M. oleifera* seed extract than the different types of bacteria followed in this investigation.

Keywords: *Moringa oleifera*, Coagulation, Semi-pilot system, Sand filter, Roughing filter.

Drinking water is essential for good health and welfare of a community and water from all sources must be hygienically safe and aesthetically acceptable. Current approaches focus on sustainable water treatment systems that are of low cost, robust and that require minimal maintenance and operation skills. Drinking water treatment involves a number of unit processes depending on the quality of the water source and the existing guidelines or standards (Ghebremichael, 2004).

The cost involved in managing water treatment depends on a number of factors basically on the cost and the availability of chemicals that are used in the water treatment system. Many of these chemicals are associated with human health and environmental problems (Crapper *et al.*, 1973; Christopher *et al.*, 1995 and Kaggwa, *et al.*, 2001). Therefore, it is desirable that other cost effective and more environmentally acceptable alternative coagulants be developed to supplement if not replace alum, ferric salts and synthetic polymers (Ndabigegensere and Narasiah, 1998).

In recent years, there has been a resurgence of interest to use natural materials due to rising cost, associated health and environmental problems of synthetic organic polymers and inorganic chemicals (Jahn, 1988). A number of effective coagulants have been identified from plant origin among of them are *Moringa*

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oleifera (Olsen,1987 and Jahn,1988), nirmali (Tripathi *et al.*,1976), okra (Al-Samawi and Shokrala,1996), *Cactus latifaira* and *Prosopis juliflora* (Diaz *et al.*,1999), tannin from *Valonia* (Özacar and Sengil,2000), apricot, peach, kernel and beans (Jahn,2001). One of the natural coagulants from animal origin is chitosan (Pan *et al.*, 1999 and Divakaran & Pillai, 2001).

Moringa oleifera besides being environmentally acceptable it is used for the production of edible vegetable oils and improvement of soil fertility. It is used also as wood and for management of watershed and catchment's areas (Jahn, 1988). *Moringa oleifera* seed can also be used as a replacement and / or supplement to chemicals used in water treatment. Many researches have reported on its use as coagulant (*e.g.* Muyibi & Evison, 1995; Ndabingengesere *et al.*,1995 and Muyibi,1998), some have focused on the efficiency of *Moringa oleifera* seed extract as a coagulant (Sutherland *et al.*,1994 and Muyibi & Okuofu,1995). The seed powder, when mixed with water yields water soluble proteins with a net positive charge dosing solution (1.3% solution) which acts as a natural cationic polyelectrolyte during treatment (Sutherland *et al.*, 1990 and NISIR, 1997). The flocculation effect on colloidal particles and cells as well as the inhibition of microbial growth implies that the protein from *Moringa oleifera* is very effective for coagulation in water treatment (Eilert *et al.*,1981 and Ali *et al.*, 2004). To date, no evidence has been found that the seeds cause secondary effects in humans, especially at the low doses required for water treatment.

The crude *Moringa* seed extract is commonly used for water purification at the household level in some areas (Jahn,1988). Recently, efforts are being made to use it for water purification at treatment plants for community water supplies (Olsen, 1987; Jahn, 1988; Muyibi & Evison, 1995; Ndabingengesere *et al.*, 1995; Sutherland *et al.*, 1990 and Nkhata, 2001).

This paper discusses the results obtained from semi-pilot scale treatment trials carried out using the crude water extract of *Moringa oleifera* seeds as natural coagulant.

Material and Methods

The semi-pilot system was constructed and installed at El-Giza Water Works (Egypt). The main water source supplying the system is the raw Nile River water which was pumped to the experimental system by the main pump of the water plant.

The construction of the semi-pilot system

The general layout of the treatment unit was represented in Fig. 1. The system consists of four main units:

Flocculation tank

The flocculation tank was manufactured from galvanized steel of dimensions 1.0×0.65×1.0 m with active dimensions 0.75×0.65×1.0 m. This tank was provided with a baffle to make turbulence to mix the coagulant with raw water. Also, bars installed on top to support a blender.

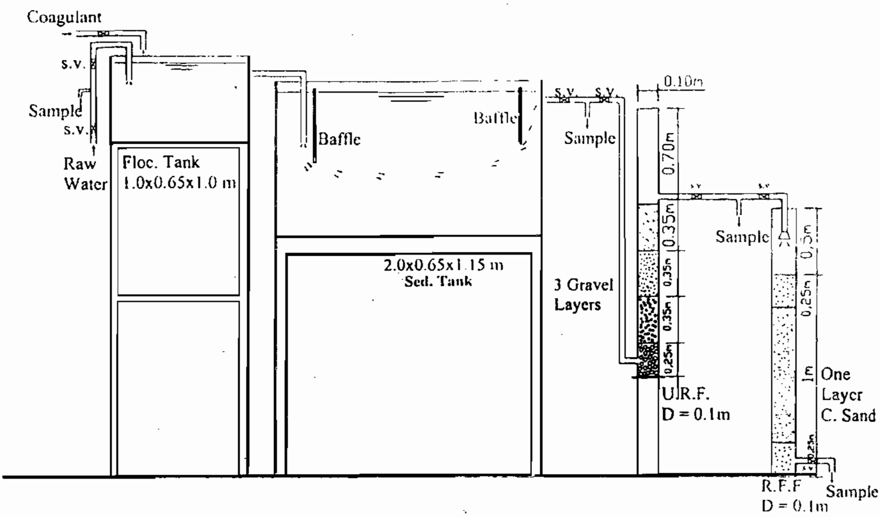

Fig. 1. The layout of the treatment unit.

Sedimentation tank

The sedimentation tank was made from galvanized steel of dimensions 1.15×0.65×2.0 m, with active dimensions 0.75×0.65×2.0 m. With adjusting the flow rate, these dimensions could lead to retention time ranging from 2.0 to 4.0 hr which might be suitable for flock formation.

Roughing filter (gravel column)

The pilot system includes UPVC pipe with 1.75 m height and 0.1 m diameter; it was used as an up-flow roughing filter. This filter bed is composed of graded gravel layers placed on top of each other decreasing in particle size. The total thickness of the filter bed is 1.1m. The filter was provided with sample collecting device. Figure 1 shows a cross section in the up-flow roughing filter (URF)

Sand filter (sand column)

UPVC pipe with 1.75 m height and 0.1 m diameter was used as rapid sand filter after filling with sand. The sand used as a filter medium is the same used in filter medium of GWTP, with thickness about 0.9 m. This sand column has a 25 cm layer of gravel in both the top and bottom of the column. The water direction was down-flow in rapid sand filter (RSF).

Drainage system

As shown in Fig. 1 the over-flow of URF, RSF, flocculation tank, sedimentation tank plus treated water is discharged to inspection chamber (60×60cm).

Each step of the pilot treatment system was controlled by valves in order to regulate and control the flow rate and the discharges from each unite. Two flow rates were applied, 0.15 l/sec and 0.1 l/sec.

Preparation of Moringa oleifera seed suspension

Dry *Moringa oleifera* seeds were obtained from the Botanical Garden, Faculty of Science, Ain Shams University, Egypt. The seeds were air dried and after being ground up the ground material was sieved through sieve No. 26 and kept in a dark well closed container. The extraction was done according to Ali *et al.* (2004).

Microbiological examinations

Water samples were collected from different steps in the semi-pilot treatment system using *Moringa* seed extract. The samples include raw water, after coagulation step, after roughing filter and after sand filter, at the flow rate 0.1 and 0.15 l/sec. Microbiological characteristics of water were measured according to APHA (1998). These include algae (green algae, blue-green algae and diatoms), total bacterial counts (at 22°C and 37°C), faecal indicators (total coliforms, faecal coliforms and faecal streptococci). Enumeration of total yeast and *Candida albicans* and total staphylococcus (as a new indicator of pollution), salmonellae, *Listeria* group and total vibrio (as pathogenic bacteria) were carried out according to El-Taweel and Shaban (2003) .

Results and Discussion

The results of preliminary jar test experiment for evaluating and optimizing the coagulation and flocculation processes using *M. oleifera* seeds extract showed that 150 mg/l have high efficiency in removing different algal species as well as different bacterial parameters. Hence, this *Moringa* seeds dose was used throughout this study. It had been planned to carry out a full scale over a 2 week period; however, due to shortage of seed only a single 6 hr run (for each trial) was possible.

Semi-pilot scale runs at flow rate 0.15 l/sec.

Efficiency of Moringa oleifera in removing algae

Figure 2 shows the results of the runs carried out using 150 mg/l *M. oleifera* seeds extract. It can be seen that, removal of different algal groups following flocculation, sedimentation and filtration increased stepwise. Diatom removal was higher than blue-green and green algal groups. The percentage removal of diatoms group was 72%, 72% and 87% at the successive treatment steps. Blue-green and green algae were removed at 52%, 52%, 60% and 40%, 45% and 75%, respectively, which lead to a total percentage removal of 82% after sand filtration step .

It has been reported (Muyibi and Evison, 1995) that, *M. oleifera* seed extract could achieve turbidity removal between 92 and 99%. Also, with inlet turbidities of 270-380 NTU turbidity was reduced to below 4 NTU in the finished water produced from a pilot and full scale trials in Malawi using *Moringa oleifera* seed as coagulant (Sutherland *et al.*, 1994).

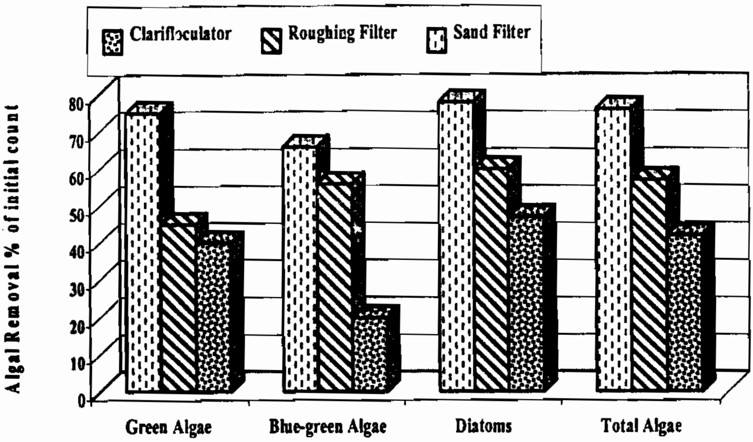

Fig. 2. Percentage removal of different algal groups after treatment with *Moringa oliefera* seeds at flow rate 0.15 l/sec.

Efficiency of M. oleifera seeds extract in removing classical bacterial indicators

Table 1 represents the data of bacteriological parameters determined in the outlet of water works plant and in the experimental semi-pilot system conducted at 0.15 l/sec flow rate. This table shows that the water plant could remove the classical bacterial indicators (total bacterial counts at 22 and 37°C, total and faecal coliforms as well as faecal streptococci) at the end of treatment and produced water acceptable for drinking from the bacteriological point of view. The semi-pilot system only reduced these bacterial parameters by one and two logs. The percentage removal after flocculation, sedimentation and filtration were up to 89% and 84% for total bacterial counts at 22 and 37°C, respectively. Faecal bacterial indicators (total and faecal coliforms as well as faecal streptococci), showed percentage removals up to 98%, 90% and 89%, respectively.

From the obtained results it is clear that, the semi-pilot plant after treatment with *M. oleifera* at flow rate (0.15 l/sec.) produced water not acceptable for drinking according to the Egyptian Standard (Egyptian Standards, 1995). This may be due to the operating time not sufficient to improve water quality, also the lack time between operating times. The coagulation and bacterial reduction studies that were carried out by Madsen *et al.* (1987) on turbid Nile water in the Sudan using *M. oleifera* seeds and observed that turbidity reduction of 80-99.5% parallel by a bacterial reduction of 90-99.9% within the first one to two hours of treatment.

TABLE 1. Classical bacterial indicators in water from El-Giza water treatment plant and from the pilot system after treatment with *Moringa oleifera* at flow rate (0.15 l/sec.).

Sampling site	Total bacterial counts/ml at		MPN index/ 100 ml		
	22 °C	37 °C	T. C.	F. C.	F. S.
- Raw water	$8.3X10^3$	$5.0X10^3$	$1.6X10^4$	$3.4X10^2$	$5.0X10^2$
- Plant flocculator	45	52	Nil	Nil	Nil
- % Removal	99.5	99	100	100	100
- Plant outlet	49	44	Nil	Nil	Nil
- % Removal	99.4	99	100	100	100
- Pilot flocculator	$8.8X10^2$	$8.0X10^2$	160	34	21
- % Removal	89.4	84	99	90	95.8
-Pilot roughing filter	$6.6X10^2$	$6.3X10^2$	240	17	50
- % Removal	92	87.4	98.5	95	90
- Pilot sand filter	$8.9X10^2$	$8.0X10^2$	300	34	53
- % Removal	89.3	84	98	90	89.4

T. C.= Total coliforms F.C.= Faecal coliforms
F. S.= Faecal streptococci

Semi-pilot scale at flow rate 0.1 l/sec

Efficiency of M. oleifera seeds extract in removing algae

The results obtained from the semi-pilot system operated at 0.1 sec for 6 hr with the test material added at 150 mg/l are given in Fig. 3. Removal rates of algae within after clarification were approximately 42%, 42% and 51% for green, blue-green and diatoms, respectively. The use of roughing filter and sand filter following the clarifloculator led to a substantial increase in algal removing rate (Fig. 3). Consequently, total algal count removing rate showed clear reduction due to the treatment with *M. oleifera* dose.

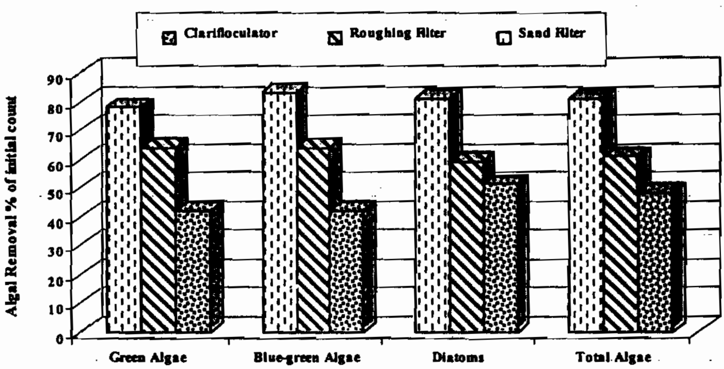

Fig. 3. Percentage removal of different algal groups after treatment with *Moringa oliefera* seeds at flow rate 0.1 l/sec.

From the results obtained at both flow rates, it can be concluded that the change in flow rate had a pronounced effect on the removing rate of total algal count especially in clarifloculator treatment step. However, there was no clear difference between the removal rates due to the other treatment steps (roughing filter and sand filter) at the applied flow rates.

Efficiency of M. oleifera seed extract in removing classical and new indicators and some pathogenic bacteria

Tables 2 and 3 represent the data of classical bacterial indicators determined in the outlet of water treatment plant and in the pilot experiment conducted at 0.1 l/sec flow rate. From the results it was found that flocculation by alum at the plant had higher percentage removal than flocculation by *M. oleifera* for total and faecal coliforms and faecal streptococci. However, total bacterial counts at 22 and 37°C increased after flocculation in the pilot system. After roughing and sand filters, the same observation was recorded for total bacterial counts. Total coliforms, faecal coliforms and faecal streptococci were removed by the percentages 78%, 66% and 73%, respectively. In general, both the plant and pilot system produced water not acceptable for drinking, where the total and faecal coliform and streptococci in the water works were found 23, 23 and 9 MPN/100 ml. This might be due to failure in the operation process.

TABLE 2. Classical bacterial indicators in El-Giza water treatment plant and the pilot plant after treatment with *Moringa oleifera* at flow rate (0.10 l/sec.).

Sampling site	Total bacterial counts/ml at		MPN index/ 100 ml		
	22 °C	37 °C	T. C.	F. C.	F. S.
- Raw water	$1.2X10^3$	$6.0X10^2$	$1.1X10^3$	$2.7X10^2$	$1.3X10^2$
- Plant flocculator - % Removal	$1.2X10^2$ 90	87 85.5	Nil 100	Nil 100	Nil 100
- Plant outlet - % Removal	32 97.3	24 96	23 97.9	23 91.5	9 93
- Pilot flocculator - % Removal	$1.6X10^4$	$9.3X10^3$	360 78.2	90 66.7	60 53.8
-Pilot roughing filter - % Removal	$1.2X10^3$ 0.0	$1.3X10^3$	240 78.2	90 66.7	26 80
- Pilot sand filter - % Removal	$1.3X10^3$	$1.6X10^3$	160 85.5	34 87.4	35 73

T. C.= Total coliforms F.C.= Faecal coliforms

F. S.= Faecal streptococci

TABLE 3. New indicators of pollution and pathogenic bacteria at El-Giza water treatment plant and after treatment by *Moringa oliefera* extract at flow rate 0.10 l/sec.

Sampling site	New indicators of pollution/ 100 ml			Pathogenic bacteria/ 100 ml		
	T. Yeast	*C. albicans*	T. Staph	Salmonellae	T. vibrio	*Listeria*
- Raw water	$1.6X10^2$	12	$2.4X10^3$	$6.4X10^2$	$4.0X10^2$	$3.6X10^3$
- Plant flocculator - % Removal	35 78	30	54 97.8	Nil 100	$4.0X10^2$ 96	$3.0X10^2$ 91.7
- Plant outlet - % Removal	64 60	43	15 99.4	4 99.4	16 96	42 98.8
- Pilot flocculator - % Removal	$2.2X10^2$	18	66 72.5	24 96.3	60 85	80 97.8
- Pilot roughing filter - % Removal	$1.3X10^2$ 18.8	14	32 98.7	13 98	40 90	45 98.8
- Pilot sand filter - % Removal	$1.2X10^2$ 25	Nil 100	12 99.5	Nil 100	18 95.5	15 99.6

With regard to new indicators of pollution (total yeast, *Candida albicans* and total staphylococcus) and selected pathogenic bacteria (salmonellae, total vibrio and *Listeria* group), it is clear that both systems (plant and pilot) failed to remove these parameters from raw water, except *C. albicans* and Salmonellae which were removed from water at the outlet of the pilot system only. In addition, the results in Table 3 showed that total yeast were more resistant to treatment by *M. oleifera,* where the percentage removal was 25% only. Generally, the semi-pilot system using *M. oleifera* had better reduction of tested parameters than the plant system using alum.

Chlorination

At the flow rate 0.1 l/sec the semi pilot system was conducted with prechlorination and postchlorination (disinfectant) treatment step. Removing rate of different algal group revealed that (Fig. 4) percentage removal of total algae was 62%, 76% and 90% at the different treatment step, successively.

From the data obtained from the semi pilot system (Table 4), it is clear that the semi-pilot system could reduce the initial count of total bacterial count by 41% while 93% in the flocculated water in the water plant. The faecal bacteria were reduced in the water plant with higher rate than in the semi-pilot system (Table 4).

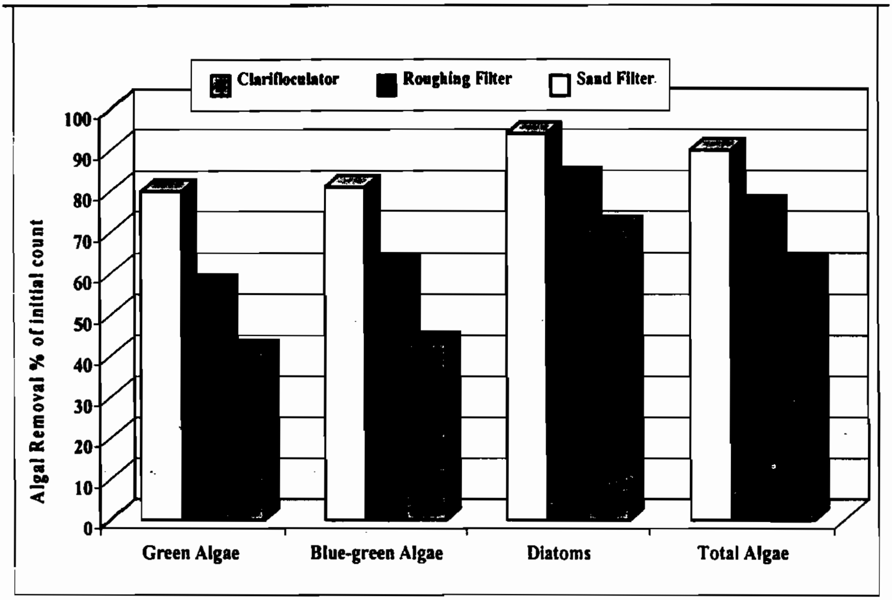

Fig. 4. Percentage removal of different algal group after treatment with *Moringa oliefera* seeds at flow rate 0.1 l/sec and prechlorination.

TABLE 4. Classical bacterial indicators in El-Giza water treatment plant and the pilot plant after treatment with *Moringa oleifera* with prechlorination.

Sampling site	Total bacterial counts/ml at		MPN index/ 100 ml		
	22 °C	37 °C	T. C.	F. C.	F. S.
- Raw water	$6.4X10^3$	$5.6X10^3$	200	90	200
- Plant flocculator	$3.9X10^2$	$3.3X10^2$	Nil	Nil	Nil
- % Removal	93.9	94.1	100	100	100
- Plant outlet	67	67	Nil	Nil	Nil
- % Removal	99	98.8	100	100	100
- Pilot flocculator	$1.3X10^3$	$3.3X10^3$	260	90	40
- % Removal	79.7	41.1		0.0	80
- Pilot roughing filter	$1.4X10^3$	$1.8X10^3$	110	90	40
- % Removal	78.1	67.9	45	0.0	80
- Pilot sand filter	$2.2X10^3$	$2.1X10^3$	100	60	2
- % Removal	65.6	62.5	50	33.3	99

T. C.= Total coliforms F.C.= Faecal coliforms
F. S.= Faecal streptococci

The addition of chlorine as postchlorination (disinfectant) was conducted at two different contact times (30 and 60 min) and at two chlorine doses (0.5 & 1.0 mg/l Cl^-). Figure 5 shows the results of post-chlorination which indicated that the removing rate of green and blue-green algae was highly affected by the contact time and chlorine dose. On contrary, postchlorination had no effect on the removing rate of diatoms group. So, there is no clear variation in the removing rate of total algal count due to the change in contact time and chlorine dose.

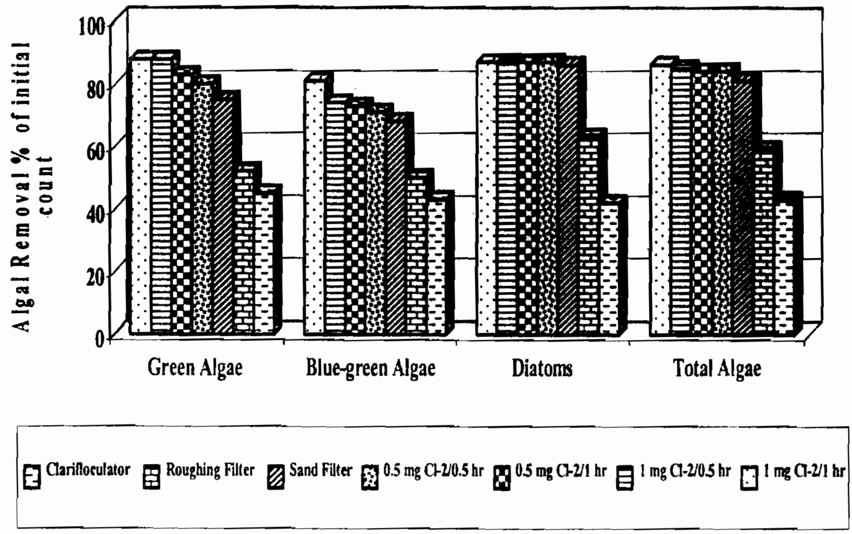

Fig. 5. Percentage removal of different algal group after treatment with *Moringa oliefera* seeds at flow rate 0.1 l/sec and postchlorination.

Regarding to the effect of chlorine addition by using different doses and different contact time on classical, new indicators and selected pathogenic bacteria (Tables 5 and 6). The data in Table 5 shows that 0.5 mg/l chlorine at 30 min more effective for removal of classical bacterial indicators than 0.5 mg/l chlorine at 1 hr. On the other hand, the same percentage of removals occurred by using 1 mg/l chlorine at both times. To remove the residual bacteria in water at the semi-pilot system, other chlorine doses and contact time must be tested. Table 6 represents the data of new indicators of pollution (total yeast, *C. albicans* and total staphylococcus) and selected pathogenic bacteria (salmonellae, total vibrio and *Listeria* group). From the obtained results, it can be concluded that *C. albicans* more resistant parameter for chlorine doses and total staphylococcus, salmonellae and *Listeria* group more sensitive than others. Ghebremichael (2004) stated that the flocculation effect on colloidal particles and cells as well as the growth inhibition on microorganisms imply that the protein from *M. oleifera* may be effective for both coagulation and disinfection in water treatment.

TABLE 5. Effect of postchlorination on classical bacterial indicators at the effluent of the pilot plant system after treatment with *Moringa oleifera* extract.

Sampling site	Total bacterial counts/ml at		MPN index/ 100 ml		
	22 °C	37 °C	T. C.	F. C.	F. S.
- Raw water	$1.4X10^4$	$1.2X10^4$	$1.1X10^3$	$3.0X10^2$	$3.0X10^2$
- Plant flocculator	$1.8X10^4$	$2.8X10^4$	$2.1X10^2$	80	80
- % Removal			80.9	73.3	73.3
- Plant roughing filter	$5.2X10^4$	$5.1X10^4$	$2.6X10^2$	80	30
- % Removal			76.4	73.3	90
- Pilot sand filter	$6.1X10^4$	$5.5X10^4$	$2.8X10^2$	80	30
- % Removal			74.5	73	90
- 0.5 mg chlorine 30 min	$2.9X10^3$	$2.9X10^3$	23	23	23
- % Removal	79.3	75.8	97.9	92.3	92.3
- 0.5 mg chlorine 1 hr	$1.1X10^4$	$4.2X10^3$	23	12	23
- % Removal	21.4	65	97.9	96	92.3
- 1.0 mg chlorine 30 min	$1.3X10^3$	$1.2X10^3$	23	12	23
- % Removal	90.7	90	97.9	96	92.3
- 1.0 mg chlorine 1 hr	$1.4X10^3$	$1.1X10^3$	23	12	23
- % Removal	90	90.8	97.9	96	92.3

T. C. = Total coliforms F.C. = Faecal coliforms
F. S. = Faecal streptococci

TABLE 6. Effect of postchlorination on new indicators and some pathogenic bacteria at the effluent of the pilot system after treatment by *Moringa oliefera* extract.

Sampling site	New indicators of pollution/ 100 ml			Pathogenic bacteria/ 100 ml		
	T.Yeast	*C. albicans*	T.Staph	Salmonellae	T. vibrio	*Listeria*
Raw water	$1.6X10^2$	12	$2.4X10^3$	$6.4X10^2$	$4.0X10^2$	$3.6X10^3$
-Pilot flocculator	$2.6X10^3$	30	$2.6X10^3$	$5.0X10^2$	$2.8X10^2$	$3.8X10^3$
- % Removal				21.9	30	
- Pilot roughing filter	$4.1X10^3$	66	$2.8X10^3$	$4.0X10^2$	$3.1X10^2$	$4.0X10^3$
- % Removal				37.5	22.5	
- Pilot sand filter	$2.2X10^3$	36	$1.4X10^3$	$2.2X10^2$	$1.1X10^2$	$2.3X10^2$
- % Removal			41.7	65.6	72.5	93.6
- 0.5 mg chlorine 30min	43	17	22	13	34	52
- % Removal	73.1		99.1	98	91.5	98.6
- 0.5 mg chlorine 1 hr	76	28	41	Nil	42	35
- % Removal	52.5		98.3	100	89.5	99
- 1.0 mg chlorine 30min	58	32	56	12	36	22
- % Removal	63.8		97.7	98.1	91	99.4
- 1.0 mg chlorine 1 hr	63	25	17	15	28	14
- % Removal	60.6		99.3	99.8	93	99.6

Data from this experiment reported in Tables 5 and 6 show that the pilot system and chlorine doses reduce only the initial count for each parameter without complete removing.

Finally, it can be concluded that the reason for pilot system failure to produce water complying with the regulation of drinking water may be:

1- The operating time was short.
2- The system had no back wash system.
3- In the non-operating time the bacterial count must have increased due to appropriate conditions liable to be provided under these circumstances.

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تقييم استخدام مستخلص بذور *المورينجا أوليفيرا* فى إزالة البكتريا و الطحالب على المستوى النصف تطبيقى

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للحصول على مياه شرب نظيفة و صالحة للاستخدام الآدمى تهدف الاتجاهات الحديثة إلى إيجاد تكنولوجيا بسيطة ، منخفضة التكاليف ، تتميز بسهولة التشغيل، ولا تحتاج إلى أعمال صيانة و متابعة مستمرة و تكون بديلا للطرق التقليدية المتبعة فى محطات معالجة مياه الشرب. و يعتبر استخدام بذور نبات *المورينجا* أحد هذه البدائل حيث يطلق على هذا النبات أنه نبات صديق للبيئة لما له من مميزات عديدة حيث أن جميع أجزاء هذا النبات لها فوائد صحية و بيئية واقتصادية.

وقد تم خلال هذا البحث بناء نموذج نصف تطبيقى فى محطة مياه الشرب (بالجيزة) يمثل خطوات المعالجة فى محطات المياه حيث يتكون من وحدة ترويق و ترسيب ثم وحدة مرشح زلطى خشن ثم وحدة مرشح رملى. و ذلك بهدف استخدامه كنموذج للمراحل المختلفة المستخدمة فى عمليات تنقية مياه الشرب حيث يستخدم مستخلص بذور نبات *المورينجا* فى عمليات الترويق بدلا من كبريتات الالومنيوم (الشبة) و التى تستخدم فى عمليات الترويق التقليدية داخل المحطات.

ومن أهم النتائج المتحصل عليها أن التغير فى معدل تدفق المياه له تأثير كبير على كفاءة أستخدام مستخلص بذور نبات *المورينجا* كمجلط للشوائب الموجودة فى المياه فقد أدى معدل تدفق المياه البالغ ٠,١ لتر/ثانية إلى زيادة نسبة إزالة الشوائب من المياه أكثر من معدن التدفق الذى بلغ ٠,١٥ لتر/ثانية. بالأضافة إلى ذلك أوضحت النتائج أرتفاع نسبة إزالة المجاميع المختلفة للطحالب (طحالب خضراء ٧٨%- طحالب خضراء مزرقة ٨٥%- دياتومات ٨٠%) عن نسبة إزالة العديد من سلالات البكتريا المستهدفة خلال البحث مما يثبت أن المجاميع المختلفة للطحالب أكثر تأثرا و هى الأكثر استجابة للتأثير المجلط لمستخلص بذور نبات *المورينجا*.