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Improving the Quality of Sewage Water in Al-Gabal Al-Asfar Area in Egypt by Using Effective Microorganism (EM)

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Abstract: Wastewater treatment is one from main problems for keeping water at constant level of environment quality of human life. The water sector in Egypt is facing many challenges including water scarcity and deterioration of water quality because of continuous increasing of population and poor of financial resources. Fragmentation of water management and lack of awareness about water challenges are also a big problem. The national water balance prepared for Egypt indicated that there was an overall deficit of approximately 8 billion m^3. This shortage was compensated by raising the efficiency of available water resources utilization through reuse of drainage water and using ground water.The objective of this study was to investigate the effect of effective microorganism (EM) on improving the quality of sewage water from Al-Gabal Al-Asfar area in Egypt. In the laboratory experiment, different doses of EM were used (5, 10, 50 and 100 ml per liter of sewage water) in the treatment. The EM formulation was evaluated for increasing in pH, dissolved oxygen (DO) and reduction in biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), total soluble solid (TSS), nitrate(NO_3),chordate(Cl),total coliform and fecal coliform. Most of the parameters that were tested showed distinct reduction. The results of the study indicated that EM has the potential to improve the effectiveness of treatment of sewage water. This study concluded that the percentage removal of (BOD) was 75.9%, (COD) was 76.6%, (TDS) was11%, (TSS) was 98.5%, (NO_3) was 85.9%, (Cl) was 82.2%, Moreover, the most probable number (MPN) of indicator bacteria reduced to total coliform and fecal coliform was 99.9% and 99.8%, respectively at 5ml concentration after 20 days incubation.

Key words: Wastewater · Microorganisms · Biological treatment

INTRODUCTION

There has been growing concern that the world is moving towards a waste crisis. There are major political implications for scarcity of water in the Middle East region. The reuse of wastewater is one of the main options being considered as a new source of water. The standards required for the safe use of wastewater and the amount and the type of wastewater treatment needed are essential. The problem of wastewater treatment in Africa includes limited government fund, lack of coordinated prevention and control policies and insufficient awareness [1, 2].

Collection of domestic wastewater and transport distant to treatment plant is a difficult and expensive task, especially in rural and sparsely populated areas. On the other hand, the need for treatment and safe disposal of the sewage originating from such areas require the development septic tank- absorption trench which is the simplest and cheapest on- site system is an attractive solution [3]. New technologies are being produced to assist in the treatment of sewage water. One of the new technologies being proposed is the use of EM. The technology of effective microorganisms was developed during the 1970's at the University of Ryukyus, Okinawa, Japan [4]. Studies have shown that EM may have a number of applications, including agriculture, livestock, gardening & landscaping, composting, bioremediation, cleaning septic tanks, algal control & household uses [5]. The safe use of sewage is becoming a global concern for obvious health and environmental reasons. For arid and semiarid countries of limited water resources, like the Near East region, reusing treated wastewater is considered as an integral part of the total available water resources [6,1].

EM treatment technology has been used in treating sewage for more than five years now. An increasing number of overseas countries are now actively introducing EM as a government policy. As in Asian

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countries, it is spreading in Thialand, Malaysia, India, Indonesia, Korea, Taiwan, Pakistan and China. In Europe, they began to use EM for solving environmental problems (Netherlands, Austria and Spain) [7,8].

The use of effective microorganisms (EM) for reducing volumes of sewage sludge has often been suggested as feasible in either wastewater treatment plants or on-site wastewater treatment systems such as septic tank and industrial effluents. In the present study, effective microorganism was evaluated for domestic sewage water treatment efficacy under laboratory condition [9]. Such technology may be possible to make the best use of its advantage to remediate organic phosphates from water. Moreover, [9] evaluated the efficiency of EM on the degradation of dimethoate from contaminated water and suggests their role in the bioremediation of other pesticides contaminated water [10].

MATERIALS AND METHODS

The Materials Used in this Investigation Were A- Domestic Wastewater: This collected from septic tanks in Al-Gabal Al-Asfar area in Cairo. The chemical and microbiological composition of the samples is shown in Table (1), the collected samples were analyzed according to [11] at Housing and Building National Research Center.

Table 1: The chemical and microbiological composition of domestic wastewater

Parameters	Values
pH	6.4
Dissolved oxygen (DO) (mg/l)	4.7
Total dissolved solids (TDS) (mg/l)	1371
Chemical oxygen demand (COD) (mg/l)	810
Biological oxygen demand (BOD) (mg/l)	486
Total soluble solids (TSS) (mg/l)	3305
Cl^- (mg/l)	146
NO_3^- (mg/l)	35.5
Total coliform (MFC/100ml)	13×10^5
Fecal coliform (MFC/100ml)	21×10^4

B-Effective microorganism (EM): For treatment of domestic wastewater, the components of EM (1) are shown in Table (2).

Table 2: The components of EM (1):

Components of (EM1)		
1-Lactic acid bacteria:	2-Yeasts (fungi)	3-Phototrophicbacteria:
Which are used for sugar fermentation	Which convert sugars from grains into alcohol through fermentation	Which detoxifiers and/or consume waste matter produce hydrogen and carbon dioxide

Collection of Samples: Two samples (10 liter) were collected from two septic tanks in Al- Gabal Al-Asfar area before adding EM, using sterile bottles with screw lids. The samples of each septic tank were kept at 4°C.

Activation of EM (Effective Microorganisms): EM is available in a dormant state and requires activation before inoculation. Activation was prepared according to the instructions of EMRO (EM Research Organization) as follow; 5% molasses, 5% EM (primary) and 90 % water free from chlorine. Then, secondary EM was filled in special tanks until overflow and incubated for 10 days at room temperature.

Methodology: Experimental study*:* In laboratory experiment, four glasses (1 L) were used to determine the efficiency of EM in domestic wastewater treatment. One of the four decimal dilutions (5, 10, 50, 100 ml) of EM was inoculated in 1 liter of the wastewater and incubated at room temperature (25- 32 ^{0}C). Sub-samples of the treated wastewater were withdrawn after 5, 10, 15 and 20 days to determine the physico-chemical and bacteriological analyses. The effect of EM was assessed by changes in the pH, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total dissolved solids, total coliform and fecal coliform after the incubation period in the EM treated sewage sample according to [11].

Determination of Total Coliform and Fecal Coliform: Total coliform and fecal coliform population was studied both control and treatment with serial dilution technique. Serial dilution from1-10 to 10-7 were made of each wastewater sample using the peptone-NaCl diluent. Lurayle sulphate broth was used for presumptive test for both total coliform group and fecal coliform, brilliant green used for confirmatory test for total coliform group and EC media for fecal coliform.

RESULTS AND DISCUSSIONS

Studies have suggested that EM may have a number of applications, including agriculture, livestock, gardening and landscaping, composting, bioremediation, cleaning septic tanks, algal control and household wastes. In the present study, samples were taken from Al- Gabal Al-Asfar area and EM was added to it with different concentrations. EM treated domestic sewage from Al-Gabal Al-Asfar showed distinct improvement in some tested parameters under all the tested incubation period as shown below:

Effect of Different Concentration of EM on pH: Figure (1) shows the comparison between the pH levels of the four EM concentrations. This figure shows that there was an increase in pH value with increasing EM content and there is little change in pH with time for the same concentration of EM. Results also showed that after completion of the trial, the pH tended to normal with in range (6- 8.2).

Effect of Different Concentration of EM on DO: Using different concentration of EM 100, 50, 10 and 5 ml\L. Dissolved oxygen (DO) was increasd from 4.7 mg/L after putting EM to 6.8, 7.09, 7.4 and 7.08 mg/L, respectively after 20 days incubation as shown in Figure (2).

Effect of Different Concentration of EM on BOD: The data show that the BOD value of raw wastewater was 486 mg/L. After EM treatment, its values were decreased to a minimum value of 117.2 mg/L, with reduction percentage of 75.9% after 20 days at concentration 5 ml\L of EM as shown in Fig (3). Biological oxygen demand (BOD) was decreased by using low concentration of EM with increase in incubation time.

Data presented in Figure (4) indicated that reduction of COD value at different concentration of EM. There is an increase in COD after putting EM then COD starting to decrease; the maximum reduction was 76.6% using 5 ml\L EM concentration after 20 days incubation.

Effect of Different Concentration of EM on TDS: The obtained results in Figure (5) showed that TDS values were decreased from 1371 mg/L to 1220.8 mg/L at 5ml\L EM concentration after 20 days incubation, that mean it decreased by 11% after 20 days incubation. However, it is believed that some impact upon the solids content of septic tanks by EM (Szymanski and Patterson, 2003).

Effect of Different Concentration of EM on TSS: The results showed that TSS was decreased from 5832 to 86.4 mg\L at 5ml\L of EM concentration after 20 days concentration as shown in Figure (6), it decreased by 98.5% after 20 days incubation.

Effect of Different Concentration of EM on NO_3: Figure (7) showed that NO_3 has been reduced from 35.5 to 5 mg\L at 5ml\L of EM concentration after 20 days concentration, that mean it decreased by 85.9% after 20 days incubation.

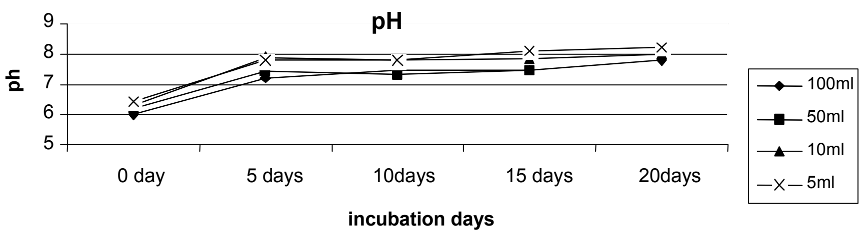

Fig. 1: Mean pH values at different concentrations of EM and at different incubation period

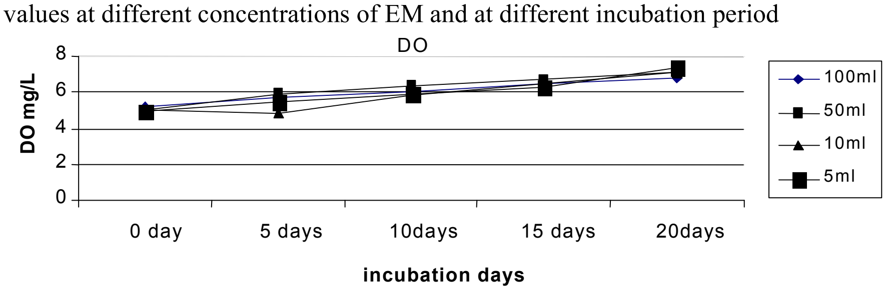

Fig. 2: Mean DO values at different concentrations of EM and at different incubation period

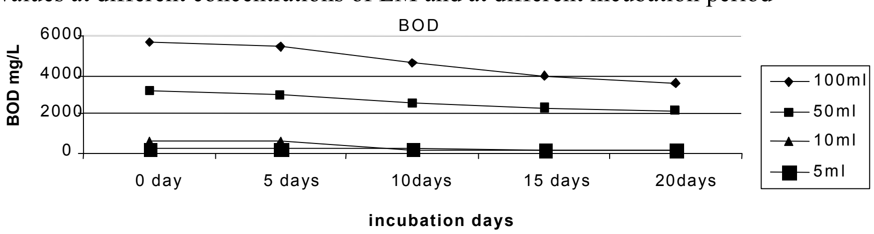

Fig. 3: Mean BOD values at different concentrations of EM and at different incubation period

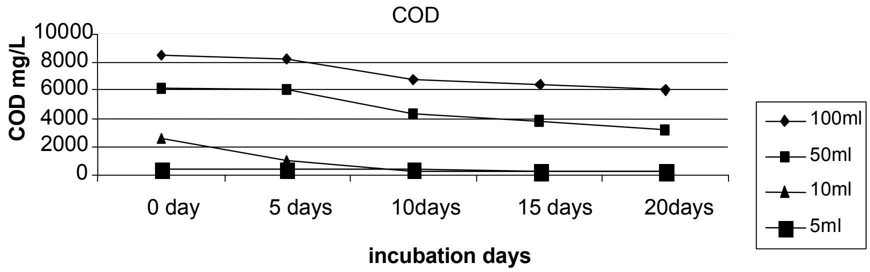

Fig. 4: Mean COD values at different concentrations of EM and at different incubation period

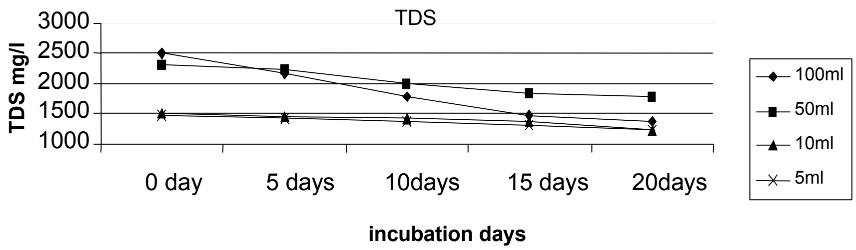

Fig. 5: Mean TDS values at different concentrations of EM and at different incubation period

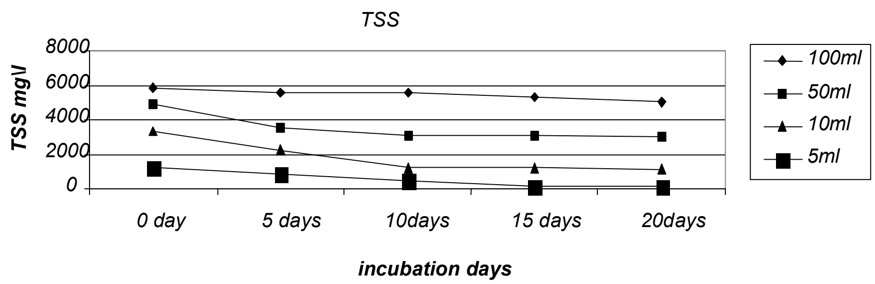

Fig. 6: Mean TSS values at different concentrations of EM and at different incubation period

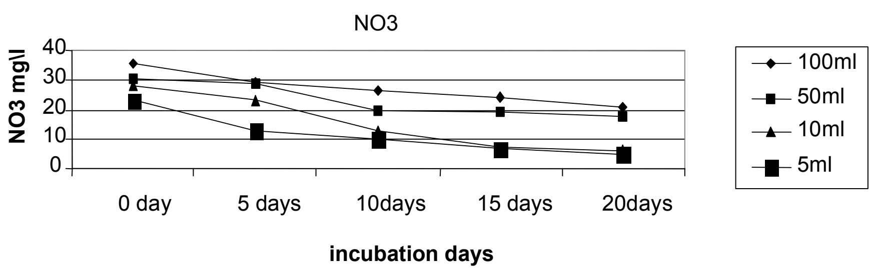

Fig. 7: Mean NO_3 values at different concentrations of EM and at different incubation period

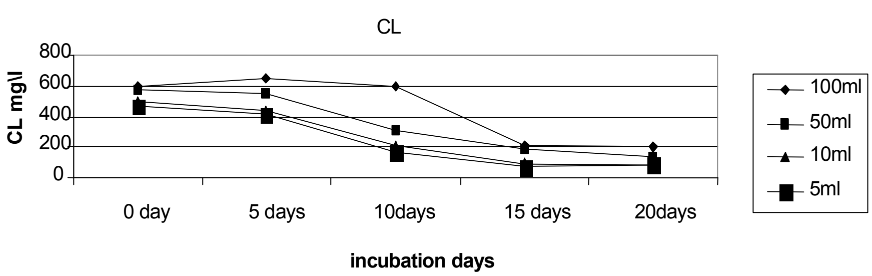

Fig. 8: Mean Cl values at different concentrations of EM and at different incubation period

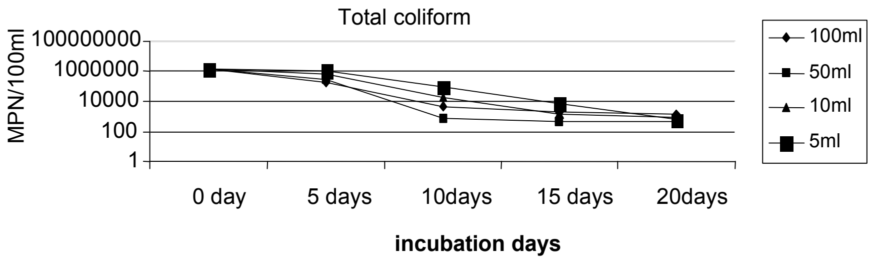

Fig. 9: Mean total coliform values at different concentrations of EM and at different incubation period

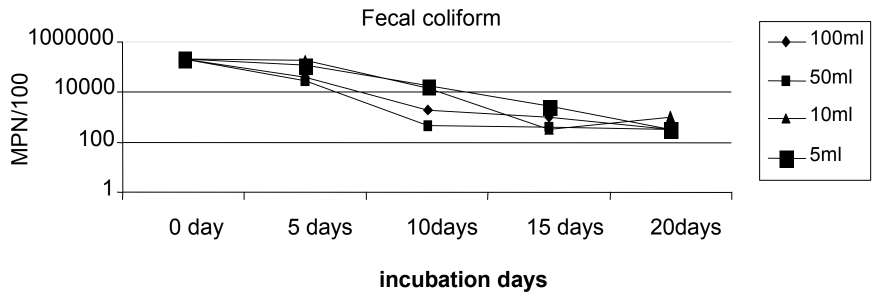

Fig. 10: Mean fecal coliform values at different concentrations of EM and at different incubation period

Effect of Different Concentration of EM on CL: Figure (8) indicated the Cl was decreased from 594.6 to 82 mg\L at 5ml\L of EM concentration after 20 days concentration, that mean it decreased by 86.2% after 20 days incubation.

Effect of Different Concentration of EM on Total Coliform and Fecal Coliform Count: Total coliform and fecal coliform were count using MPN technique according to [11]. The obtained results in Figure (9) and (10) showed that the reduction of total coliform and fecal coliform count estimated by 99.9 and 99.8%, respectively at 5 ml/L of EM concentration after 20 days concentration.

The results of the laboratory experiment showed that the most effective dose of EM for sewage treatment was 5 ml of EM to 1liter of sewage (5 ‰). Thus, this concentration of EM was used in the treatment process of septic tanks.

The BOD of sewage varies from several hundred to about 1000 mg/l for raw sewage and from about 10 to 20 mg/l for good quality secondary effluent (FAO, 1992). The beneficial microorganisms present in EM might decompose the organic matter by converting it to carbon dioxide and methane or use it for growth and reproduction. This is in agreement with those reported by [7], who suggested that introducing EM into the treatment facilities helped to reduce unpleasant by-product and hence improving the water quality of discharged wastewater. This means that EM exerts effective treatment with respect to BOD.

To assess the bacteriological characteristics of treated sewage, several parameters were investigated. Figures (9& 10) summarize the total viable bacterial counts 350C and the classical indicator bacteria (total coliforms, faecal coliforms). The densities of the bacterial counts in raw sewage were 13 × 105 cfu/ ml and 21 × 104 cfu/ ml 350C, after 20 days of treatment, reduction was happen with percentage of 99.9 % and 99.8%, respectively.

The results showed that the counts of total and faecal coliform bacteria were high in septic tanks before EM treatment. This might be due to high temperature and /or shortage of domestic water used. Thus, water was not complying with [12] guideline (less than× 102 fecal coliforms/ 100 ml for wastewater reuse agricultural and aquaculture purposes). These results are in agreement with those reported by [13,4], who concluded that the numbers of coliform bacteria in Kafer El-Sheikh Treatment Plant (primary treatment) were high in the influent and effluent sewage. However, [14] reported that faecal coliforms as mean, at 108- 1011 MPN/100 ml were not in agreement with that recorded foreign countries, where the ambient temperature was mostly lower and domestic water was higher. On the other hand, the preferable density is below 100 FC/ 100ml [7,15].

Organic materials within wastewater originate from plants, animals or synthetic organic compounds and enter wastewater via a number of routes including human wastes, detergents and industrial sources [10,16]. In the current wastewater treatment process (eithermunicipal or domestic on-site) microorganisms play a significant role in the treatment of domestic sewage. Many different organisms live within the wastewater itself; assisting in the breakdown of certain organic pollutants [16].The basis for using these EM species of microorganisms is that they contain various organic acids due to the presence of lactic acid bacteria, which secrete organic acids, enzymes, antioxidants and metallic chelates [5]. The creation of an antioxidant environment by EM assists in the enhancement of the solid-liquid separation, which is the foundation for cleaning water [5,17]. One of the major benefits of the use of EM is the reduction of sludge volume. Theoretically, the beneficial organisms present in EM should decompose the organic matter by converting it to carbon dioxide (CO_2), methane (CH_4) or use it for growth and reproduction. Studies have suggested that this is the case.

CONCLUSION

- The integrated treatment system can treat domestic wastewater with low to medium strength and the final treated effluent can meet the limits of the Egyptian Code of Practice (ECP 501-2005) regarding effluent reuse in unrestricted irrigation. Moreover, the treatment system produced effluent that complies with the limits of Law 48 for the Year 1982, regarding the disposal of treated effluents into agricultural drains.
- Application of EM1 to wastewater reduced its toxic effect and in sewage sludge could also be effectively treated with EM1 and be used for crop production.
- EM1has the potential to improve the overall effectiveness and efficiency of the activated sludge process for treatment of domestic sewage water.
- The benefits of using EM1in treating wastewater to saving water by making recycling water possible, Also, it used for clean toilets and foul oder reduced.
- Treatment of wastewater with EM1 for 20 days followed with corn increase DO and minimal influences on pH.
- EM1was needed due to low number of microorganisms in wastewater and continuous pollution from the wastewater.
- The treatment unit decreased considerably the pathogenic species as represented by fecal coliform.

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