Sustainable Treatment of Wastewater using Effective Microorganisms

D.K. Kale[1] and P.D. Anthappan[2]

[1]Department of Biotechnology, R.J. College, University of Mumbai, Ghatkopar (W), Mumbai – 400 086, India.
[2]Department of Microbiology, Bhavan's College, University of Mumbai, Bhavan's College, Munshi Nagar, Andheri (W) Mumbai – 400 058, India.

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Rapid economic developments in the current century have certainly enhance the human lifestyle, on the other hand they have also resulted in the degradation of environment, due to excessive use of natural resources, thereby generating excessive wastes. The kitchen waste, which is one of the typical common example of household waste, has been a big concern for the municipal corporation authorities with respect to their treatment. There are many scientific techniques that have been discovered and used for the treatment of waste and their disposal into the natural resources. The present study has attempted to use one such new technique, Effective Microorganisms Technology (EM – Technology), in which natural sources have been utilized to convert the waste into a byproduct. EM can be either used in extended form or in bokashi form and have a number of applications, including agriculture, livestock, composting, bioremediation, cleaning septic tanks, algal control and household uses. The waste management by use of EM-technology has been adapted by many countries. The present study it indicated that the use of EM technology has desirable effect on reduction of pH, BOD_5, COD, TS, TDS, TSS, Nitrate and Phosphate contents of waste water.

Key words: Effective Microorganisms, Activated Effective Microorganisms, Bokashi.

Demand for fresh water posed by growing population, urbanization and industrialization coupled with poor rainfall have ultimately led to water scarcity in many areas in India. While water crisis exists on one hand, the limited water reserves available are being polluted by the quantity of waste generated due to urbanization and industrialization. Wastewater comprises of a variety of inorganic and organic substances[1]. Therefore numbers of chemical and biological methods are being employed by municipalities for the treatment of waste water but are not sufficient. Therefore, the situation of waste water has now become alarming and there is a pressing need to employ an effective method like EM for waste treatment.

Recently, a number of biological and chemical technologies have emerged for waste water treatment prior to its disposal into natural habitats. Some technologies have been devised to

* To whom all correspondence should be addressed.
Mob.: +91-9892415191
E-mail: kaledipti_k@rediffmail.com
kaledipti_k@yahoo.co.in

aim at an easy and cost effective method for the treatment of waste water and it's conversion into a useful product that can be utilized for irrigation of crops. One of this new technology being proposed is the use of Effective Microorganisms (EM)[3].

The Effective Microorganisms technology respects nature and does not contain genetically engineered microbes. These microorganisms are collected from the natural environment from within the country and therefore are indigenous. EM contains selected species of microorganisms such as predominant populations of lactic acid bacteria, yeast, photosynthetic bacteria, smaller quantities of actinomycetes, fermenting fungi and other types of microorganisms. All of these are mutually compatible with one another and coexist in liquid culture[4,5]. The principle of EM is the conversion of a degraded ecosystem full of harmful microbes, to a one that is productive and contains useful microorganisms. It is either used in activated form or by preparation of bokashi for the treatment of waste water. Many countries have adapted this method for the waste management[6-13].

Since every treatment system is in itself a separate ecosystem, one has to custom-design each application for a waste treatment system after the proper assessment of the entire system. The indicators like pH, BOD, COD, total solids, total dissolved solids, total suspended solids, Nitrate and Phosphate need to be estimated before and after the treatment of waster water, to observe the efficiency of the selected process (2). BOD is defined as the amount of oxygen required by bacteria while stabilizing the organics in wastewater under aerobic conditions, at a particular time and temperature. Sewage with high BOD can deplete oxygen in receiving waters, causing fish kills and ecosystem changes. COD is another most commonly measured constituent of wastewater. This is a measure of the total quantity of oxygen required for oxidation of organics into carbon dioxide and water by use of chemicals. Total solids (TS) comprise the combination of total suspended solids (TSS) and total dissolved solids (TDS). These mainly represents suspended solids and dissolved solids that are organic and inorganic in nature. Excess of nitrate and phosphate into waster causes lethal effect known as eutrophication have a massive impact on ecosystem[2].

This study is aimed to study desirable effect of EM technology on reduction of pH, $BOD_{5,}$ COD, TS, TDS, TSS, Nitrate and Phosphate contents of waste water.

MATERIAL AND METHODS

Viable count of EM and bokashi

The viable count of EM and bokashi were carried out by use of different media like Rogosa agar (For Lactobacilli species), Sabouraud Dextrose Agar (For yeast), Kenknight & Munaier's Agar (For Actinomycetes), Mineral Salts Succinate Agar (For Rhodospirillum Species).

Preparation of EM bokashi ball

5 ml. of EM 1 (Mapple Orgotech Ltd.) was added to sterile jaggery water, prepared by dissolving ten grams of black jaggery in 85 ml. of chlorine free water. The solution was kept in a closed container and incubated away from direct sunlight for 7 days. The solution was known as activated 10ml EM, which was then mixed with 1gm. of zeolite. It was mixed thoroughly, and ball of approx. 1gm. each was prepared. Each ball was covered with banana leaf and kept in closed polythene bags for 4-5 days to allow fermentation. After fermentation, these balls were called EM bokashi ball[7].

Collection and treatment of waste water

Waste water was collected from the Kitchen of Excel Industry. Approximately 1 lit. of waster was immediately used for physico-chemical analysis. The remaining water sample was distributed into 8 containers (8 lit. in each) to prepare two sets (SET-A, SET-B). Eight bokashi balls/ container were added into six containers (Test) and remaining two was utilized as control. Out of two set, SET – A was terminated after one week and SET – B was terminated after two week of incubation. The water sample from both the set was subjected for physico-chemical analysis.

Physico- Chemical analysis of water sample

The physico-chemical analysis was carried out before and after treatment of wastewater with EM bokashi. The parameters which were studied was pH, BOD, COD, TS, TDS, TSS, NO_3, PO_4 to study the effectiveness of treatment. Estimation of BOD (by Wrinkler's method), COD (by KMnO4 number method), TS, TSS, TDS, NO_3 (by Brucine sulphate method), PO_4 (by Molybdenum method)[14, 15].

RESULTS AND DISCUSSIONS

The viable count of EM and bokashi were carried out to observe the different types of species.

Viable count of EM sample

Name of the Species	Count
Lactobacillus Species	27×10^{11} / ml.
Yeast	38×10^{10} / ml.
Actinomycetes	25×10^{4} / ml.
Rhodospirullum	Nil

Viable count of Bokashi (Liquid) sample

Name of the Species	Count
Lactobacillus Species	48×10^{2} / ml.
Yeast	36×10^{2} / ml.
Actinomycetes	Nil
Rhodospirullum	Nil

The results of physico-chemical analysis carried out on the sample are shown in table 1, the pH of the untreated liquid waste sample was observed to be (7.9) slightly alkaline. After treatment with bokashi for 1 week the pH of test samples was acidic, which could be due to lactic acid production, supporting the growth of effective microorganisms into the test samples while the control pH was reported to (7.5). While at the end of 2 week incubation, the pH of treated as well as untreated samples was neutral.

The present study has used one of such new technique Effective Microorganisms Technology (EM – Technology) in which natural source has been utilized to convert the waste into byproduct. Analysis of the all the generated data of treated and untreated waste water samples observed that $BOD_{5,}$ COD, TS, TDS, TSS, Nitrate and Phosphate contents of treated water were reduced to tolerable environmental standard as reported by other workers[6-13]. Based on result obtained from liquid treatment, it will be interpreted as one of the easy method which can be applied locally to convert the waste into byproduct which can help to reduce the environmental pollution.

Table 1. Physicochemical analysis of Waste water sample

TEST	Initial	Waste water							
		Set-A (1 Week Incubation)				Set-B (2 Week Incubation)			
			Test				Test		
		Control	L1	L2	L3	Control	L1	L2	L3
pH	7.9	7.5	6.8	6.5	6.3	7.5	7.2	7.1	7.5
BOD_5mg. / lit.	0.0947	0.0843	0.0617	0.0640	0.0610	0.0726	0.0346	0.0306	0.0300
CODmg. / lit.	148	129.34.	86.68	84.68	83.34	112.06	46.06	44.06	48.66
TSgm. / lit.	0.452	0.424	0.372	0.360	0.384	0.412	0.292	0.280	0.264
TDSgm. / lit.	0.292	0.280	0.240	0.224	0.252	0.264	0.184	0.172	0.160
TSSgm. / lit.	0.160	0.144	0.132	0.136	0.132	0.148	0.108	0.108	0.104
NO_3mg. / lit.	6.7	5.9	2.9	2.7	2.7	6.1	1.9	1.7	2.1
PO_4mg. / lit.	2.2	1.93	1.10	1.06	1.00	1.73	0.43	0.43	0.50

L1, L2, L3 – Samples from Set- A and Set - B

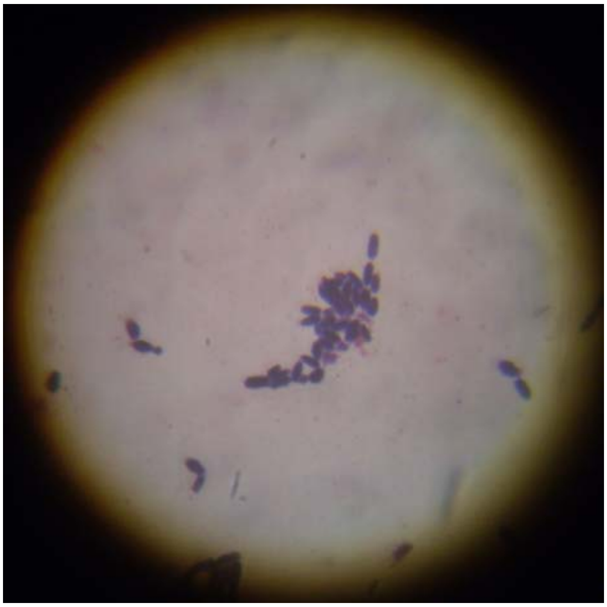

Plate 1. Gram Staining of EM Solution

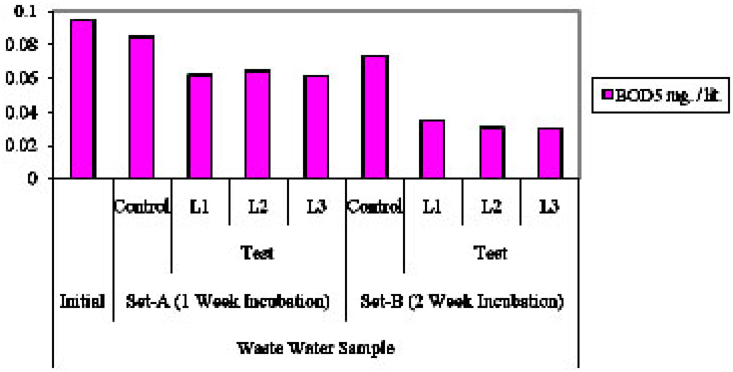

Fig. 1. Graph representing the effect of EM- Technology on BOD_5 of waste water sample

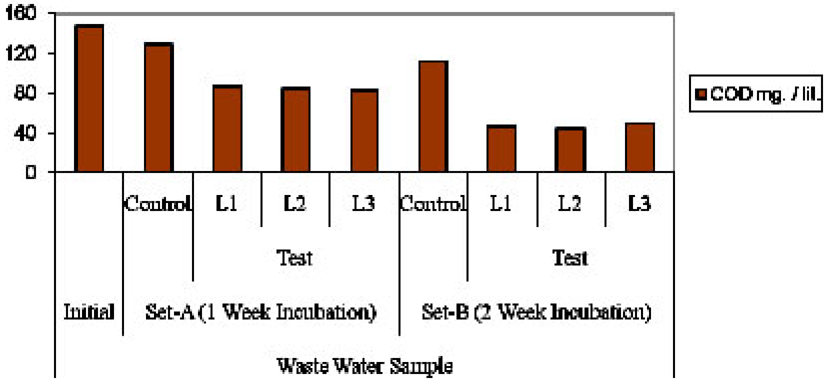

Fig. 2. Graph representing the effect of EM-Technology on COD of waste water sample

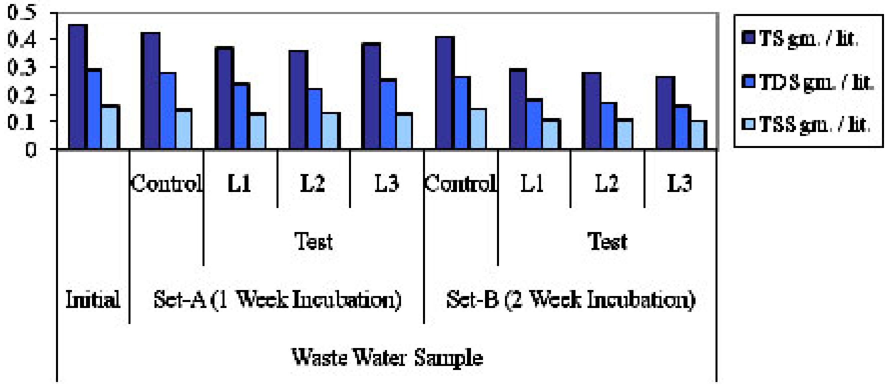

Fig. 3. Graph representing the effect of EM-Technology on TS, TDS, TSS of waste water

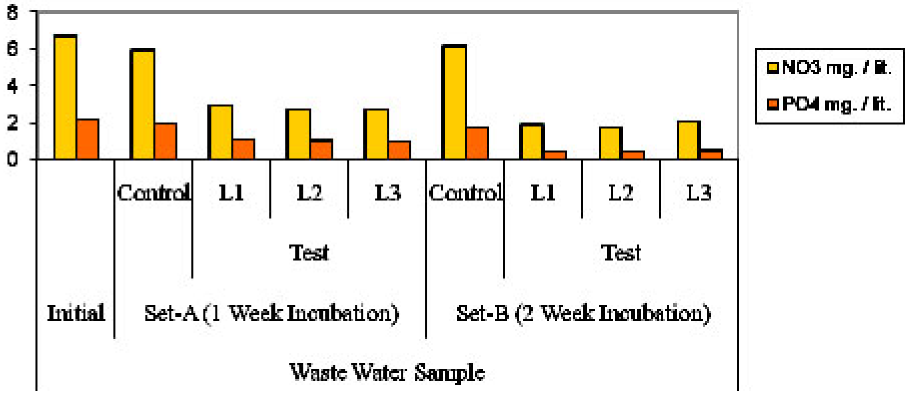

Fig.6. Graph representing the effect of EM-Technology on NO_3 and PO_4 of waste water

CONCLUSION

Economic development through industrialization, agriculture for the better future of our society results in environmental deterioration. Severity of degradation depends upon the waste generated due to these activities and also its disposal into the environment. Hence the best strategies could be to reduce the waste generation and treat the waste at local level instead of collecting large amount from different sources and then subjected to final disposal. The present study was undertaken to determine the use of one of such new technique i.e. effective microorganisms for the treatment of kitchen solid and water waste. The indicators like pH, BOD, COD, total solid, total dissolved solid, total suspended solid, Nitrate and Phosphate estimated before and after the treatment of waster water, to observe the efficiency of selected process. There was appreciable reduction in the above mentioning values which has been observed by other studies, supported the theory for use of EM technology for liquid waste management[6-13].

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