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Solid waste management by use of Effective Microorganisms Technology

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Abstract : The quantity of waste generated due to urbanization pose a major problem of proper and adequate treatment, so that its final disposal should not cause environment pollution. Many scientific techniques have been discovered for proper waste management, followed by its disposal. But today, it is necessary to use such a method which can convert waste into reusable by-product. Thus with the aim to combat pollution, this research topic highlights the use of one of the simple and easy method; Effective Microorganism (EM) Technology, is the one in which organisms from natural sources are utilized to convert waste into a reusable byproduct. It has desirable effect of increase in organic carbon (OC), organic matter (OM), nitrogen (N), phosphate (PO_4) and potassium (K) content of waste. In this study it was found that OC, OM, N, PO_4, K, increased at an average of 22.67%, 39.09% , 1.84%, 95mg./lit, 2.88mg./lit. respectively when compared with control where the EM was not added . Based on the result obtained , it was concluded that the use of EM technology has desirable effect which has been observed by many studies.

Keywords: Effective Microorganisms, Activated Effective Microorganisms, Bokashi, Waste Management.

Introduction:

Human being while living in tune with environment for development also destroyed nature by various activities. Due to this process there is problem of environmental degradation due to excess use of natural resources and generation of waste. Many scientific techniques such as incineration, biological processing etc. have been discovered for the treatment of waste and then dispose into the natural resources. The kitchen waste is one of the typical household's waste shows a major impact on municipalities for the treatment. Many techniques have been suggested for the treatment of the same, but most of them are not possible to use at local level. Therefore, it is very essential to use such a technique which will convert the waste into a useful byproduct. One of them is Effective Microorganism Technology which was utilized for treatment of different type of waste to convert them into useful byproduct.

The technology of Effective Microorganisms was developed by Higa and Parr (1994) and Higa (1995). The technology was based on the presence of microorganisms which include three principal types of organisms commonly found in all ecosystems, namely Lactic Acid Bacteria, Yeast, Actinomyces and Photosynthetic bacteria (Higa , 1995). EM either used in extended form or in bokashi form. Bokashi means "fermented organic matter" is a method of intensive composting. Bokashi is commonly made with only molasses, water, EM and wheat bran. 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 uses. The waste management by use of EM technology has been adapted by many countries (Dasho, 2007; Sayed, 2003a,b; Sekeran *et al.*, 2005).

The plants requires micronutrients for growth, which is either available from soil or by addition of artificial fertilizers. Organic matter is very important component in the movement of nutrients in the environment and plays role in water retention on the surface of planet (Black,1954). Nitrogen is one of the important component many macromolecules like proteins, enzymes, amino acids, amines etc. due to its

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requirement for different metabolic activity of the plants. The deficiency of the same causes a chlorosis effect which can be treated by addition of nitrogen in the form of organic manure and artificial fertilizers (Black, 1954). Phosphorus is a part of a key structural component like DNA, RNA in plants and functional compounds like ATP in plants. The deficiency of this nutrient causes a stunt growth of the plants. The natural weathering process or addition of artificial fertilizer provides nutrient to plants. Potassium is one of the major nutrients required by plants for the movement of water, nutrient and carbohydrate in plant tissue, while deficiency of this causes a stunted growth.

This study is aimed to study desirable effect of EM technology on solid waste management with its conversion into a desirable eco- friendly byproduct.

Materials & 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

In 500 ml. of flask 425 ml. of chlorine free water was mixed with 50 gm. of black jaggery and autoclave at 10 lbs. for 10min. to dissolved jaggery. The solution was cooled at room temperature for 2 hrs. and 25 ml. of EM solution was added into it. The mixture was mixed with 6 Kg. of rice bran and 2 Kg. each of this content was filled into plastic bag and incubated at room temperature for fermentation for 2 weeks (Sekeran *et al*., 2005).

Collection and treatment of solid waste

Solid waste was collected from the Kitchen of Industry situated at western suburb of Mumbai. Approximately 1.5 kg. of solid waste was immediately used for physico-chemical analysis. The remaining solid waste was subjected for EM technology treatment. 1 kg. of solid waste and 1kg. of EM - Bokashi was arranged in layered form into plastic bag. Total six such bags were prepared with two control bags (solid waste without Bokashi). The bags were named as Set A: - S1, S2, S3 (Solid - Test) SC (Solid Control), Set B: - S1, S2, S3 (Solid Test), SC (Solid control). Both set was incubated at room temperature. Set A was terminated after 1 week incubation and Set B was terminated after 2 week incubation, the sample was selected by Quartering Technique for the physico - chemical analysis (Sekeran *et al* ., 2005).

Estimation of Organic matter by Walkley and Black's Method

The sample was dried first in an oven for about 24 hr. at 110^{0}C and was ground well. Then it was passed through 0.2 mm non-ferrous sieve. 100 mg. of sample was placed in a conical flask of 500 ml. capacity and in it 10 ml. of 1N potassium dichromate solution was added. The flask was stirred for a min. Then 20 ml. of conc. H_2SO_4 was added to it and again the flask was stirred for a minute. The mixture was allowed to stand for 30 minutes. It was then diluted to 200 ml. with distilled water and to which 10ml. of Conc. phosphoric acid and 1ml. of diphenylamine indicator was added. The sample was now back titrated with 0.4 N ferrous ammonium sulphate solution. At the end point this colour changed to brilliant green giving a one drop end point. The blank was prepared in the same way. The organic carbon was calculated as follows (Saxena, 1998).

Formula:-

Organic Carbon content of sample

$$\% = \frac{10 \times (B - T)}{B} \times 0.003 \times \frac{100}{W}$$

Where,

T = volume of ferrous ammonium sulphate solution used for sample titration (ml.)

B = volume of ferrous ammonium sulphate solution used for blank titration (ml.)

W = Weight of the sample

Formula for calculation of Organic Matter:-

Organic Matter % = Organic carbon X 1.724

Estimation of Nitrogen by Kjeldhal digestion Method

The sample was grounded and 10 gm. grounded sample passed through screen was taken into Kjeldhal flask and 25 ml. distilled water was added to moisten the sample. 20 gm. of catalyst mixture and 35 ml. of conc. H_2SO_4 were added and swirled; it was heated at low temperature for 10-30 min. until frothing was stopped. Digestion was continued until the contents become light yellow with rotating the flask at regular intervals. Further it was heated for 1 ½ hr. to release all residual nitrogen. Digest was cooled and about 100 ml. of distilled water was added. It was mixed well and allowed to stand for few minutes. Supernatant was then transferred in 1lit. distillation flask. 4-5 washings were carried out with distilled water and transferred to the same distillation flask, leaving behind as much as sample possible. This prevents bumping in distillation flask. 100 ml. of 40% NaOH and few pieces of Zn were added to the content and swirled to help smooth boiling of mixture. 500 ml. conical flask containing 25 ml. of boric acid + mixed indicator was placed below the condenser so the tip of it dips into the solution. Assembly was connected and distillation was commenced. The content was titrated with 0.1 N HCl until the colour changed to light brown pink

The total nitrogen was calculated as follows.

Formula for calculation of Nitrogen:-

$$\text{Nitrogen}(\%) = \frac{(a\text{-}b) \times N \text{ of HCl} \times 1.4 \times V}{v \times s}$$

Where

a = Volume of HCl used with sample (ml.).

b = Volume of HCl used with blank (ml.).

V = Volume of total digest (ml.)

v = Volume digest distilled.

s = weight of sample.

Estimation of Inorganic phosphate by Molybdenum Method

The sample was dried first and ground well. In 10 mg. of sample 200 ml. of (0.002N) H_2SO_4 was added and mixed for about half an hour. The suspension was filtered through Whatmann No. 50 and filtrate used as unknown. The standard phosphate was prepared by dissolving 10 mg. of anhydrous K_2HPO_4 in 1 lit. of distilled water. The standard range was prepared in distilled water by using standard stock solution. The rage of 1 – 10 mg. / lit. has been prepared. The standard phosphate solution and unknown was mixed with 1ml. of acid molybdate and 0.2 ml. of ascorbic acid the all tubes were incubated at room temperature for 30 min. The color intensity was measured at 645 nm. The intensity of color is directly proportional to the amount of phosphate present in the sample.

The standard graph of standard was plotted by concentration of standard in mg. / lit. on X axis and optical density at 645 nm. on y axis. The phosphate content of an unknown sample was calculated as follows

Formula for calculation of phosphate:-

$$PO_4 \text{mg./ gm.} = \frac{Ps \times V}{1000 \times W}$$

Where,

Ps = PO_4 estimated in suspension (mg. / lit.) (i.e. Value obtain from standard graph)

V = Total volume of suspension (ml.)

W = Weight of air dry sample (gm.)

Estimation of Potassium by Flame photometry Method

In 50gm. of air dried sample 100 ml of 40% ethyl alcohol was added and incubated at room temperature for 10min. Solution was filtered through Whatman filter paper No. 50. The residue was washed on filter paper with 40% ethyl alcohol and finally with absolute ethyl alcohol. In the residue 100 ml. of ammonium acetate solution was mixed and allowed to stand overnight. The supernatant was filtered through Whatman filter paper no. 50, the filtrate was used as unknown. The stock of 100 mg. / lit KCl was used as a standard potassium solution. From the stock a range of 2mg/lit – 10mg/lit was prepared by the use of distilled water as a diluents. The potassium content of standard solution and unknown was measured by use of flame photometry at 769 nm filter (Saxena, 1998).

Formula for calculation of Potassium:-

$$\text{Potassium (mg. / gm.)} = \frac{A \times V}{10000 \times S}$$

Where,

A = Potassium content in mg. / lit. in the solution.

V = Total volume of soil extract prepared

S= Weight of sample taken.

Result

The viable count of EM and Bokashi were carried out to observe the different types of species as mentioned in Tables 1 and 2 respectively. The Gram staining of EM solution has been given in Figure 1.

Table 1:- Viable count of EM sample

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

Table 2:- Viable count of Bokashi (Solid) sample

Name of the Species	Count
Lactobacillus species	31 x 10^{2} / ml.
Yeast	46 x 10^{2} / ml.
Actinomycetes	Nil
Rhodospirullum species	Nil

Figure 1 : Gram Staining of EM Solution (Under 100X)

The kitchen solid waste was treated with EM-Bokashi for 1 and 2 weeks. The characteristics of treated and untreated solid waste such as organic carbon, organic matter, total nitrogen, phosphate and potassium are given in Table 3.

Table 3:- Analysis of treated (with EM Bokashi) and untreated (without EM bokashi) solid waste sample

TEST	WASTE SOLID										
	Initial	Set-A (1 Week Incubation)					Set-B (2 Week Incubation)				
			Test					Test			
		Control	S1	S2	S3	Mean	Control	S1	S2	S3	Mean
OC %	3.39	3.21	24.25	23.75	23.89	23.96	2.72	22.57	22.78	22.68	22.67
OM %	5.84	5.53	41.80	40.94	41.18	41.30	4.80	38.91	39.27	39.10	39.09
N_2 %	1.10	1.04	1.10	1.30	1.24	1.21	1.15	1.88	1.85	1.81	1.84
PO_4 mg. / gm.	57.00	55.05	67.95	66.45	67.95	67.45	65.55	94.50	94.50	96.00	95.00
K mg. / gm.	2.14	2.14	2.54	2.54	2.46	2.51	2.26	2.86	2.92	2.86	2.88

The effect of EM technology used in this study on OC and OM of waste are shown in Figure 2 while nitrogen, phosphate and potassium waste have been given in Figure. 3, 4 & 5.

Figure 2:- Graph representing the effect of EM- Technology on OC and OM of waste solid sample

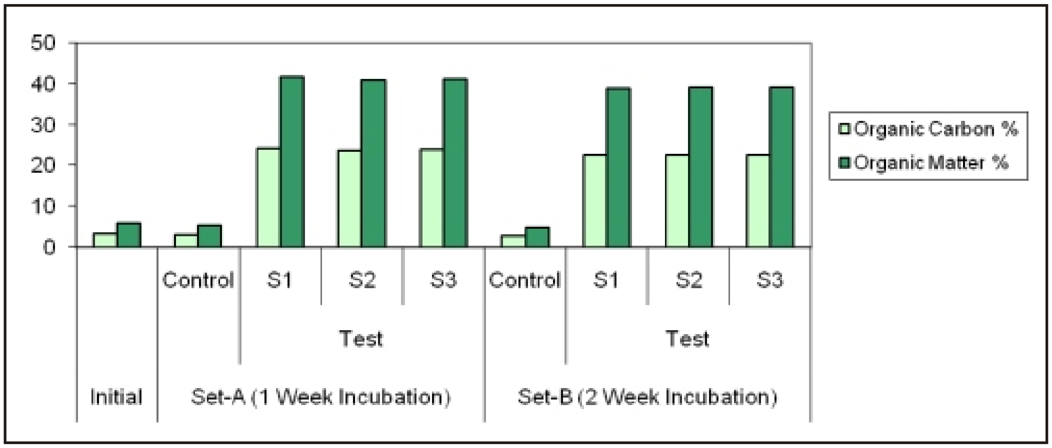


Figure 3:- Graph representing the effect of EM- Technology on nitrogen of waste solid sample

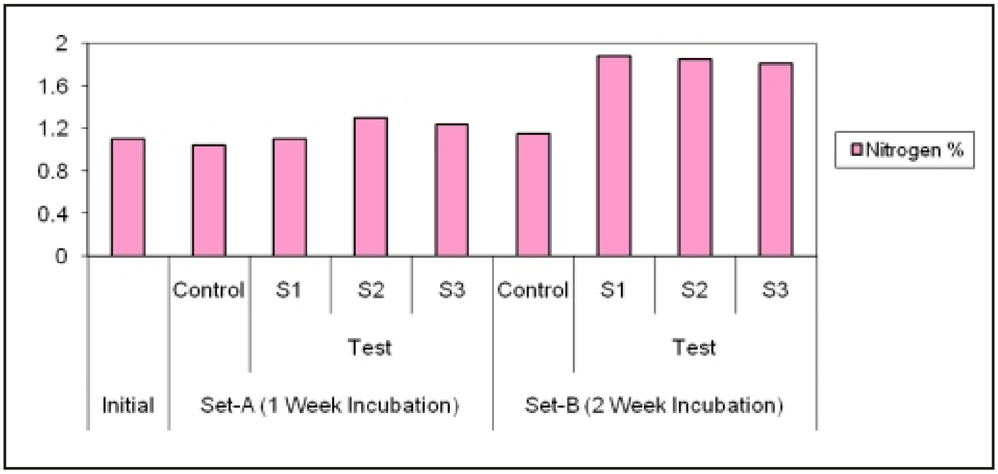


Figure 4:- Graph representing the effect of EM- Technology on phosphate of waste solid sample

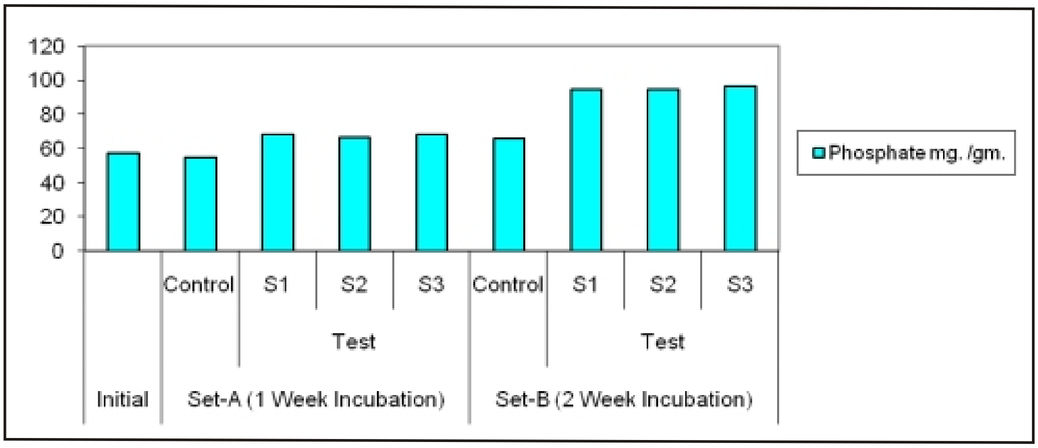
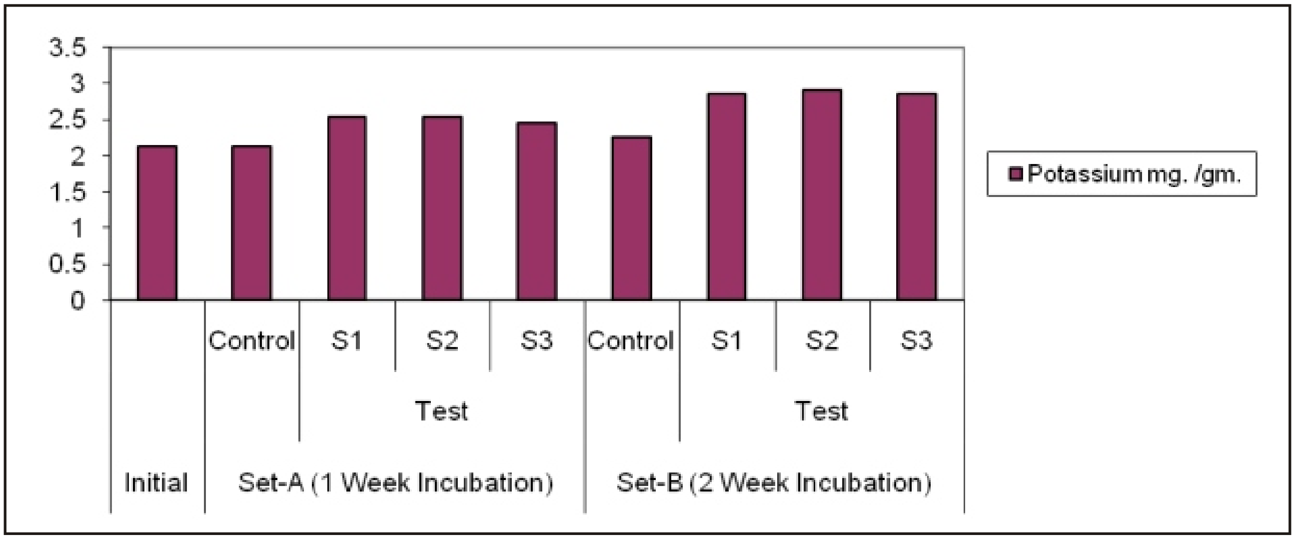


Figure 5:- Graph representing the effect of EM- Technology on potassium of waste solid sample



Discussion:

Due to industrialization process there is problem of environmental degradation by excess use of natural resources and generation of waste. Many scientific techniques have been discovered for the treatment of waste and then dispose into the natural resources. The present study has used one of new technique, effective microorganisms technology (EMT), in which natural source has been utilized to convert the waste into byproduct. Based on result obtained from solid waste treatment, it was concluded that the use of EM technology has desirable effect by significant increase in organic matter, nitrogen, phosphate and potassium content of waste which has also been observed by Sayed (2003a,b) and Sekeran *et al.* (2005). The present study suggests that treatment of kitchen waste may reduce the load of solid and liquid wastes at large scales by municipalities. The result of the present study further confirms that solid waste samples, organic matter, nitrogen, phosphate and potassium content were significantly increased as indicated by previous investigators (Higa & Parr, 1994; Higa 1995). The present technique is the easiest method to convert the waste into byproduct which can be utilized as an eco-friendly soil fertilizer.

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