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Domestic Waste Water Treatment Using Effective Microorganism (EM) Technology

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***Abstract*: EM or Effective Microorganisms is a microbial inoculants containing many kinds of naturally occurring beneficial microbes. Maple EM-1 is activated using Jaggery water. Fruit and vegetable wastes were collected and inoculated with Jaggery water EM. The physical (Odour, Appearance and Colour) chemical (pH, TDS, BOD, COD, Alkalinity) and biological (Population of Coliforms including E.coli, Lactobacillus population, Yeast population and Actinomyces population) parameters of leachate from each sample are examined at an interval of 7 days. There was a generation of alcohol and vinegar like smell in the due process other than non-offensive smell. Chemical parameters such as pH, TDS (Total Dissolved Solids) and BOD shows a declining trend. An increase in COD, Alkalinity was also observed. While analyzing the biological parameters a steady decrease in Non EM organisms are seen. Lactobacillus, Actinomyces and yeast populations almost doubled within 14 days compared to control. It can be concluded that Jaggery water is the best activator of Maple EM-compost a method of waste disposal at a low cost.**

***Keywords*: Activated in Jaggery water, Chlorine free water wastewater, Effective microorganisms (EM), Maple EM-1.**

1. 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 of the same, but most of them are not possible to use at local level. Therefore, it is very essential to use such techniques which will convert the waste into a useful by product. The reduction and recycling of domestic solid and waste water has become a main problem in the present day life of each and every one.

Improper waste management facilities and treatments leads to acute environmental problems, serious health issues, visual discomfort, putrefying odour etc. and these waste piles becomes a breeding site for vectors. Solid wastes also result in air pollution, water pollution and soil pollution. The current composting techniques were initially employed as contingency plan to alleviate the problems associated with waste reduction at the sources and land filling. It is, therefore, necessary to establish and develop an efficient collection and composting system for the fruit and vegetable wastes that allows solution of problems coped with collection (offensive smell and sanitation) and production of quality composts.

One of them is Effective microorganism technology which was utilized for treatment of different type of waste to convert them into useful byproduct.

2. Methodology

A flowchart showing the methodology for Treatment of waste water by using EM Technology.

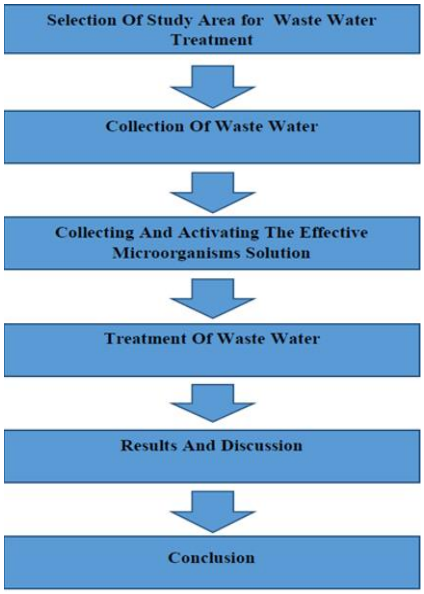

Fig. 1. Flow chart of methodology

A. Selection of study area for waste water treatment

Study area is first important parameter in our project. First we select the study area for treating domestic waste water. So we are select the domestic waste water collection study area in Samarth college canteen mess for treatment of wastewater. There is lot of daily waste water generates and from that we are

trying to treat such water and will be used for Samarth campus in gardening purpose, washing and cleaning purpose.

B. Collection of waste water

The waste water was collected in a sterilized plastic container from Samarth college of engineering canteen mess. Immediately after collection, the waste water was brought to the laboratory for further analysis. The collected waste water sample was subjected to physicochemical and microbiological analysis.

C. Collecting and activating the effective microorganism's solution

EM is available in a dormant state and requires activation before application. Activation involves the addition of 700 ml of chlorine free water and 150 ml of jaggery water to 300ml of dormant EM one week prior to application. These ingredients were mixed together in either a 2 L or 3 L container and stored in area with minimal temperature fluctuations. A major influence on the survival of microorganisms is the temperature of their environment, with significant temperature fluctuations impacting upon their survival. The pH is also a determining factor. It was indicated that the pH of the EM should be approximately 4.5.

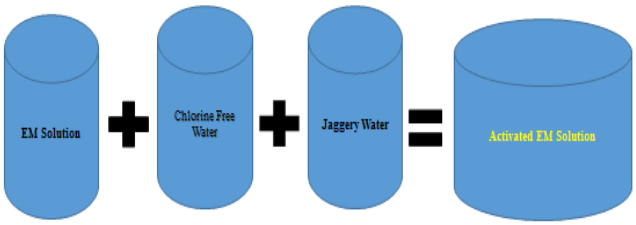

Fig. 2. Process of activating EM Solution

D. Treatment of waste water

Treatment of waste water is done after the activating the EM solution and then various test are conducted to perform the various physical properties and chemical properties are studying.

The set up consists of three 1liter Erlenmeyer flasks with 1 litre of waste water each. 100 ml of activated EM culture was added into the waste water sample. The setup was operated continuously for 21 days. The effect of EM was assessed by changes in the odour, pH, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), Dissolved Oxygen (DO), after the incubation period.

3. Treatment of Waste Water by Using EM Technology

Various test to be carried out by studying various parameters in waste water.

A. Measurement of parameter on waste water

The characteristics of Waste Water can be classified under following three heads:

- Physical Characteristics
- Chemical Characteristics
- Biological Characteristics

1) Physical characteristics

The Physical Characteristics of sewage are determined using the physical method of analysis:

a) Colour

The colour of the sewage indicates the freshness of sewage. If it's colour is greyish brown or yellowish, it indicates fresh sewage. With passage of time, as putrefaction starts it begins to get black. The colour of stale and septic sewage is black (When all the oxygen has disappeared from sewage, it becomes septic). Other colors may also be formed due to presence of some specific industrial waste. The color of the sewage can normally be detected by the naked eye.

b) Turbidity

Turbidity is the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality.

c) Total dissolved solids

Total dissolved solids (TDS) is a measure of the dissolved combined content of all inorganic and organic substances present in a liquid in molecular, ionized, or micro-granular (colloidal sol) suspended form. TDS is sometimes referred to as parts per million (ppm). Water quality levels can be tested using a digital TDS PPM meter.

2) Chemical Characteristic

a) pH

The pH value of sewage indicates the logarithm of reciprocal of hydrogen ion concentration present in the sewage. It is thus an indicator of the acidity or the alkalinity of sewage. If the pH value is less than 7, the sewage is acidic and if the pH vale is more than 7, the sewage is alkaline.

3) Biological Characteristics

a) Dissolved Oxygen

Dissolved oxygen is the amount of oxygen in the dissolved state in the wastewater. Through the wastewater generally does not have DO, its presence in untreated wastewater indicates that the waste water is fresh. Similarly, its presence in treated wastewater effluent indicates that the considerable oxidation has been accomplished during the treatment stages. While discharging the treated wastewater into receiving waters, it is essential to ensure that at least 4 mg/l of DO is present in it.

b) Biochemical Oxygen Demand

Biochemical Oxygen Demand (BOD) is defined as the amount of oxygen required by the microorganisms (mostly bacteria) to carry out decomposition of biodegradable organic matter under aerobic conditions. The BOD test is widely used to determine the pollution strength of domestic and industrial wastes in terms of the oxygen that they will require if discharged into natural watercourses. It is the one of the most important test in stream pollution control activities.

c) BOD (Biochemical Oxygen Demand) test (mg/l)

Aim: To determine the amount of BOD (Biochemical Oxygen Demand) exerted by a given sample of waste water.

Introduction:

The Biochemical Oxygen Demand (B.O.D.) of sewage or of polluted water is the amount of oxygen required for the biological decomposition of dissolved organic matter to occur under aerobic condition and at the standardized time and temperature. Usually, the time is taken as 5 days and the temperature 20°C as per the global standard. The B.O.D. test is among the most important method in sanitary analysis to determine the polluting power, or strength of sewage, industrial wastes or polluted water. It serves as a measure of the amount of clean diluting water required for the successful disposal of sewage by dilution. The test has its widest application in measuring waste loading to treatment plants and in evaluating the efficiency of such treatment systems.

Procedure:

1. Preparation of aerated distilled water: Place desired volume of distilled water in a 5 litre flask. Aeration is done by bubbling compressed air through water.
2. Add 1 ml each of phosphate buffer, magnesium sulphate solution, calcium chloride solution and ferric chloride solution for every litre of distilled water.
3. In the case of waste water which is not expected to have sufficient bacterial population, add seed to the diluted water. Generally, 2 ml of settled domestic sewage is sufficient for 1000 ml of dilution water.
4. Highly acidic or alkaline sample are to be neutralized to a pH of 7.
5. Take the sample and dilute it with distilled water and mix contents well.
6. Take diluted sample into 2 BOD bottles.
7. Fill the other two BOD bottles with dilution water alone.
8. Find DO of diluted waste water and dilution water and note them down.
9. Incubate the other two BOD bottles in a BOD Incubator for 5 days at 200C. They are to be tightly stoppered to prevent any air entry into the bottles.
10. Determine DO content in the incubated bottles at the end of 5 days.
11. Calculate the B.O.D. of the given sample.

Calculations:

$$\text{BOD in mg/l} = \left(\frac{(DO-DO5)\times Volume\ of\ bottle}{ml\ of\ sample\ taken}\right) - (Bo - B5)$$

Where:

DO = DO of diluted wastewater sample on 0th day

D5 = DO of diluted waste water sample on 5th day

BO = DO of blank solution before incubation

B5 = DO of blank solution after incubation of 5 days

$$\text{Total BOD at 0 day} = \left(\frac{(DO-DO5)\times Volume\ of\ bottle}{ml\ of\ sample\ taken}\right) - (Bo - B5)$$

$$= \left(\frac{(3.8-2.7)\times 300}{250}\right) - (1.6 - 2.7)$$

$$= 2.42\ \text{mg/l}$$

$$\text{Total BOD at 7 day} = \left(\frac{(DO-DO5)\times Volume\ of\ bottle}{ml\ of\ sample\ taken}\right) - (Bo - B5)$$

$$= \left(\frac{(3.4-2.3)\times 300}{250}\right) - (1.6 - 2.5)$$

$$= 2.22\ \text{mg/l}$$

$$\text{Total BOD at 14 day} = \left(\frac{(DO-DO5)\times Volume\ of\ bottle}{ml\ of\ sample\ taken}\right) - (Bo - B5)$$

$$= \left(\frac{(2.5-1.4)\times 300}{250}\right) - (1.9 - 2.0)$$

$$= 1.42\ \text{mg/l}$$

$$\text{Total BOD at 21 day} = \left(\frac{(DO-DO5)\times Volume\ of\ bottle}{ml\ of\ sample\ taken}\right) - (Bo - B5)$$

$$= \left(\frac{(1.7-1.5)\times 300}{250}\right) - (1.9 - 2.7)$$

$$= 1.04\ \text{mg/l}$$

Results:

Table 1
Determination of BOD

S. No.	Samples	BOD in mg/l
1	0 Days	2.42
2	07 Days	2.22
3	14 Days	1.42
4	21 Days	1.04

4. Results and Discussion

Table 2
Changes in parameters of domestic waste Water treated with EM

S. No.	Parameters	Incubation time in days			
		0	7	14	21
1	PH	10.2	8.5	6.8	5.0
2	Alkalinity (mg/l)	55.0	43.0	34.0	23.0
3	Dissolved Oxygen (mg/l)	0.9	1.38	1.75	1.90
4	BOD (mg/l)	2.42	2.22	1.42	1.04
5	COD (mg/l)	168	140	118.4	108
6	Total Dissolved Solid (mg/l)	2305	1110.5	904	885.7

The results were found and according to contaminants present in the waste water the various techniques to be used for the treatment is to be known. 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, EM treated domestic sewage showed distinct reduction in all the tested parameters under all the tested incubation period. Total dissolve solid was found to be reduced from 2305 mg/lit to 1110.5, 904 and 885.7 mg/lit pH was also reduced from 10.2 to 8.5,6.8 and 5 alkalinity was reduced from 55 mg /lit to 43, 34 and 23 mg/lit. The BOD was reduced from 2.42 to 2.22, 1.42 and 1.04. No reduction was observed in DO content. The COD was decreased from 168 to

140, 118.4 and 108 mg/litre at the respective incubation time. The analyses were carried out according to recommended ISO methods. These values are presented as the mean of three individual values measured.

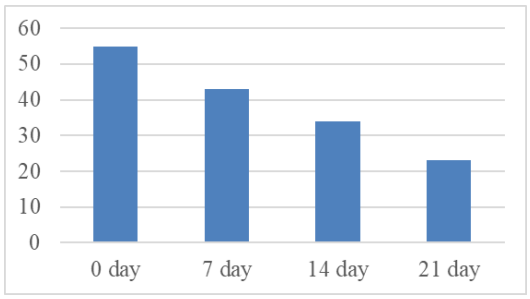

Fig. 3. Changes in alkalinity values among sample within 21 days

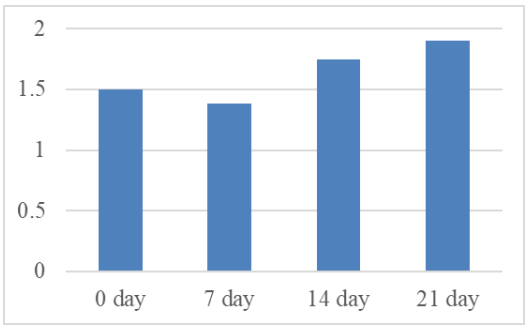

Fig. 4. Changes in dissolved oxygen value among sample within 21 days

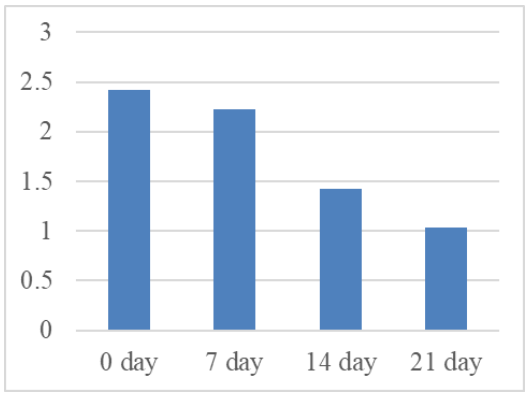

Fig. 5. Changes in BOD Values among samples within 21 days

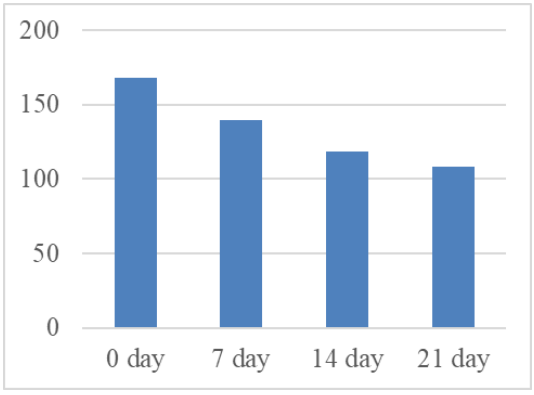

Fig. 6. Changes in COD values among samples within 21days

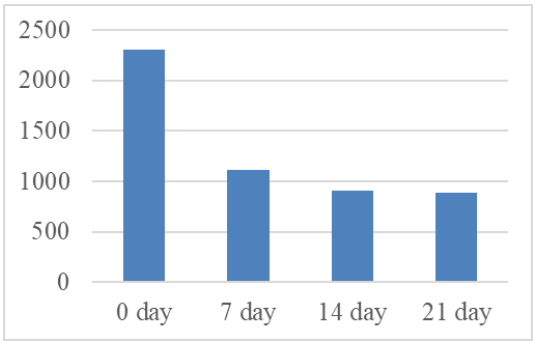

Fig. 7. Changes in TDS values among samples within 21days

5. Conclusion

To conclude, although composting is proven to be the solution for domestic solid waste management but the practice may pose a challenge.

Although all the references highlighted that EM has a great potential to be used in accelerating of composting process, but the mechanism of microbe reaction towards organic waste is prone to certain level of uncertainty which limits this issue from being addressed in most of the references.

Thus, the application of EM in domestic solid wastes composting need to be studied in further details. The tedious process and time consuming may become the challenge in EM organic composting. Nevertheless, the application of EM in accelerating the com-posting process may reduce the volume of domestic solid waste dispose in landfill if it is successfully conducted.

Economic development through industrialization, agriculture for the better future of our society results in environmental deterioration. The present study was undertaken to determine the use of one of such new technique i.e., Effective Microorganisms for the treatment of wastewater. The indicator like pH, DO, BOD, COD, TDS, were estimated before and after the treatment of wastewater, to observe the efficiency of selected process. There was appreciable reduction in the above mentioning values which has been observed by other liquid waste management.

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