Treatment of Kitchen Waste by Microbial Culture

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ABSTRACT

The growth of urban cities and ever increasing human population and the misuse and abuse of the environment has led to increased accumulation of waste materials which is polluting water, air, soil and increased risk to human life in the form epidemics. There are number of methods for solid waste management from ancient times. Some of the methods are sanitary land-fill, vermi-composting, burning, incineration, bio-gas, anaerobic composting. These methods will not prove effective in some of the circumstances such as high temperature; high moisture content so there is a need to find such a method which suites in all the environmental conditions & circumstances. The above said problems can be solved by the new methods of waste management viz. Mechanical Biological treatment (MBT) and operating system1 (OS 1dms). In these methods the culture called mega-bacillus and mother cultures are considered as key agents for degradation of organic waste. The main aim of present investigation was to know the comparison of decomposition of kitchen waste by MBT and OS 1dms and enhance the values of final product.

Key-words: - *Composting, Mechanical Biological Treatment (MBT), Operating System 1 (OS1), Solid Waste Management.*

I. INTRODUCTION

The sight of a dustbin overflowing and the stench rising from it are all too familiar sights and smells of a crowded city. You look away from it and hold your nose as you cross it. Have you ever thought that you also have a role to play in the creation of this stench? That you can also play a role in the lessening of this smell and making this waste bin look a little more attractive if you follow proper methods of disposal of the waste generated in the house?

Since the beginning, humankind has been generating waste, be it the bones and other parts of animals they slaughter for their food or the wood they cut to make their carts. With the progress of civilization, the waste generated became of a more complex nature. At the end of the 19th century the industrial revolution saw the rise of the world of consumers. Not only did the air get more and more polluted but the earth itself became more polluted with the generation of non-biodegradable solid waste. The increase in population and urbanization was also largely responsible for the increase in solid waste.

1.1 TYPES OF SOILD WASTE

Solid waste can be classified into different types depending on their source:

A. Household waste is generally classified as municipal waste
B. Industrial waste as hazardous waste
C. Biomedical waste or hospital waste as infectious waste

1.1.1 Municipal Waste

Consists of household waste, construction and demolition debris, sanitation residue, and waste from streets. This garbage is generated mainly from residential and commercial complexes. With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition changing. In 1947 cities and towns in India generated an estimated 6 million tonnes of solid waste; in 1997 it was about 48 million tonnes. More than 25% of the municipal solid waste is not collected at all; 70% of the Indian cities lack adequate capacity to transport it and there are no sanitary landfills to dispose of the waste.

Over the last few years, the consumer market has grown rapidly leading to products being packed in cans, aluminium foils, plastics, and other such non biodegradable items that cause incalculable harm to the environment. In India, some municipal areas have banned the use of plastics and they seem to have achieved success. For example, today one will not see a single piece of plastic in the entire district of Ladakh where the local authorities imposed a ban on plastics in 1998.

1.1.2 Hazardous waste

Industrial and hospital waste is considered hazardous as they may contain toxic substances. Certain types of household waste are also hazardous. *Hazardous wastes could be highly toxic to humans, animals, and plants; are corrosive, highly inflammable, or explosive; and react when exposed to certain things e.g. gases***.** India generates around 7 million tonnes of hazardous wastes every year, most of which is concentrated in four states: Andhra Pradesh, Bihar, Uttar Pradesh, and Tamil Nadu. Household wastes that can be categorized as hazardous waste include old batteries, shoe polish, paint tins, old medicines, and medicine bottles.

In the industrial sector, the major generators of hazardous waste are the metal, chemical, paper, pesticide, dye, refining, and rubber goods industries. Direct exposure to chemicals in hazardous waste such as mercury and cyanide can be fatal.

1.1.3 Hospital Waste

Hospital waste is generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities in these fields or in the production or testing of biological. It may include wastes like sharps, soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, etc. These are in the form of disposable syringes, swabs, bandages, body fluids, human excreta, etc. This waste is highly infectious and can be a serious threat to human health if not managed in a scientific and discriminate manner. It has been roughly estimated that of the 4 kg of waste generated in a hospital at least 1 kg would be infected.

Hospital waste contaminated by chemicals used in hospitals is considered hazardous. These chemicals include formaldehyde and phenols, which are used as disinfectants, and mercury, which is used in thermometers or equipment that measure blood pressure. Most hospitals in India do not have proper disposal facilities for these hazardous wastes.

1.2 HEALTH IMPACT OF SOILD WASTE

Modernization and progress has had its share of disadvantages and one of the main aspects of concern is the pollution it is causing to the earth – be it land, air, and water. With increase in the global population and the rising demand for food and other essentials, there has been a rise in the amount of waste being generated daily by each household. This waste is ultimately thrown into municipal waste collection centres from where it is collected by the area municipalities to be further thrown into the landfills and dumps. However, either due to resource crunch or inefficient infrastructure, not all of this waste gets collected and transported to the final dumpsites. If at this stage the management and disposal is improperly done, it can cause serious impacts on health and problems to the surrounding environment.

The group at risk from the unscientific disposal of solid waste include – the population in areas where there is no proper waste disposal method, especially the pre-school children; waste workers; and workers in facilities producing toxic and infectious material. Other high-risk group includes population living close to a waste dump and those, whose water supply has become contaminated either due to waste dumping or leakage from landfill sites. Uncollected solid waste also increases risk of injury, and infection.

Exposure to hazardous waste can affect human health, children being more vulnerable to these pollutants. In fact, direct exposure can lead to diseases through chemical exposure as the release of chemical waste into the environment leads to chemical poisoning.

Waste from agriculture and industries can also cause serious health risks. Other than this, co-disposal of industrial hazardous waste with municipal waste can expose people to chemical and radioactive hazards. Uncollected solid waste can also obstruct storm water runoff, resulting in the forming of stagnant water bodies that become the breeding ground of disease. Waste dumped near a water source also causes contamination of the water body or the ground water source. Direct dumping of untreated waste in rivers, seas, and lakes results in the accumulation of toxic substances in the food chain, through the plants and animals that feed on it directly or indirectly.

Disposal of hospital and other medical waste requires special attention since this can create major health hazards. This waste generated from the hospitals, health care centres, medical laboratories, and research centres such as discarded syringe needles, bandages, swabs, plasters, and other types of infectious waste are often disposed with the regular non-infectious waste.

Waste treatment and disposal sites can also create health hazards for the neighbourhood. Improperly operated incineration plants cause air pollution and improperly managed and designed landfills attract all types of insects and rodents that spread disease.

Recycling too carries health risks if proper precautions are not taken. Workers working with waste containing chemical and metals may experience toxic exposure. Disposal of health-care wastes require special attention since it can create major health hazards, such as Hepatitis B and C, through wounds caused by discarded syringes. Rag pickers and others, who are involved in scavenging in the waste dumps for items that can be recycled, may sustain injuries and come into direct contact with these infectious items.

1.2.1 Occupational hazards associated with waste handling

1.2.1.1 Infections

A. Skin and blood infections resulting from direct contact with waste, and from infected wounds
B. Eye and respiratory infections resulting from exposure to infected dust, especially during landfill operations
C. Different diseases that results from the bites of animals feeding on the waste
D. Intestinal infections that are transmitted by flies feeding on the waste

1.2.1.2 Chronic diseases

A. Incineration operators are at risk of chronic respiratory diseases, including cancers resulting from exposure to dust and hazardous compounds

1.2.1.3 Accidents

A. Bone and muscle disorders resulting from the handling of heavy containers
B. Infecting wounds resulting from contact with sharp objects
C. Poisoning and chemical burns resulting from contact with small amounts of hazardous chemical waste mixed with general waste.
D. Burns and other injuries resulting from occupational accidents at waste disposal sites or from methane gas explosion at landfill sites.

II. IMPORTANCE OF WATE REDUCTION

In the affluent countries, the main motivations for waste reduction are frequently related to the high cost and scarcity of sites for landfills, and the environmental degradation caused by toxic materials in the deposited wastes. The same considerations apply to large metropolitan areas in developing countries that are surrounded by other populous jurisdictions. The places that currently do not have significant disposal pressures can still benefit from encouraging waste reduction. Their solid waste departments, already overburdened, cannot afford to spend more money and effort on the greater quantities of wastes that will inevitably be produced as consumption levels rise and urban wastes change.

Solid waste managers in developing countries tend to pay little attention to the topic of reducing non-organic wastes because the wastes they collect are between 50% to 90% organics, dirt and ashes. These municipal wastes, however, are amenable to composting or digestion, provided they contain very low levels of synthetic materials. Solid waste departments thus have an interest in promoting diversion of synthetic recyclables from the waste stream.

Each household generates garbage or waste day in and day out. Items that are no longer needed or do not have any further use for fall in the category of waste and we tend to throw them away. There are different types of solid waste depending on their source. In today's polluted world, learning the correct methods of handling the waste generated has become essential. Segregation is an important method of handling municipal solid waste. Segregation at source can be understood clearly by schematic representation. One of the important methods of managing and treating wastes is composting.

As the cities are growing in size and in problems such as the generation of plastic waste, various municipal waste treatment and disposal methods are now being used to try and resolve these problems. One common sight in all cities is the rag picker who plays an important role in the segregation of this waste.

The garbage with proper segregation generated in households can be recycled and reused to prevent creation of waste at source and reducing amount of waste thrown into the community dustbins.

2.1 Four "R" (refuse, reuse, recycle, reduce) concepts for waste reduction

2.1.1 Refuse

The things which are present in the house can be used for different requirement in the house instead of buying the new thing every time.

2.1.2 Reuse

As far as possible try to reuse the materials so that minimum wastage is obtained. One time use concept must be eliminated.

2.1.3 Recycle

The generated waste is collected and segregated so that non-biodegradable wastes are separated and degradable wastes are composted and converted into useful manure.

2.1.4 Reduce

Reduce the generation of unnecessary waste, e.g. carry your own shopping bag when you go to the market and put all your purchases directly into it.

III. METHODS OF SOILD WASTE MANAGEMENT

The following are the some of the methods of solid waste management:

1. Open dumping
2. Open burning
3. Sanitary Land Fill
4. Incineration
5. Bio-gas (Anaerobic process)
6. Composting

The above stated all the methods are very common for waste reduction. But the first five methods mentioned will contribute the more disadvantages compared to the last method i.e. composting.

The composting method can be bifurcated into the different classifications as follow:

1. Manual method
2. Mechanical method
3. Microbial method

3.1 MICROBIAL METHOD

This is the advanced technique of solid waste management. The following are the two types of microbial method:-

A. Mechanical biological treatment (MBT)
B. Operating system 1*dms* (OS1)

3.1.1 Mechanical biological treatment (MBT)

The MBT is used as a fertilizer in agriculture which reduces the hazardous use of chemical fertilizers. The continuous concentrated and indiscriminate use of chemical fertilizers disturbs the soil health, leading to acidification, micronutrients depletion, soil degradation, reduction in the activity of micro flora and micro fauna, poor crop health and lower crop yield and quality. Besides, use of chemical fertilizers may contribute to environmental risks like increased global warming, ground and surface water pollution etc. In view of this, it is desirable that we may have to return to practices which is eco-friendly and which reduces the nutrient depletion and helps sustain quality food production, this is achieved by applying MBT.

3.1.1.1 Definition

The process of crushing the MSW with the help of mechanical instruments, adding mega-bacillus culture and keeping the crushed waste for curing in the pits or in the containers is known as Mechanical Biological Treatment. The compost obtained by this method is known as MBT-compost.

3.1.1.2 Culture Details

- Mega Bacillus (B. subtilis 2 strains):- Produces useful enzymes like amylase, protease, cellulose, and lipase.
- Phototropic bacteria: - Produces bacteria cell ATP, absorption of CO2, and breaking down of H2S.
- Ingredients: - Essential minerals and amino acid.
- Dosage: - 1 packet of Mega Bacillus can be applied up-to 15MT of organic matter.
- Characteristics:-
    - Appearance: - Light brown colour fine powder.
    - pH: - 8.0 − 8.6
    - Effective pH range: - 5.0 − 8.5
    - Effective temperature: - 10 − 45°C
    - Storage: - 2 years.

3.1.1.3 Advantages of use of mega-bacillus culture

1. Degradation of greases, fats and oil.
2. Degradation of detergent in industrial effluent and municipal sewage.
3. Degradation of cellulose matter such as the effluent of paper factory.
4. Rapid flocculation.
5. Effectively reduces BOD and COD in wastewater.
6. Keeps drain lines flowing smoothly; reduces the amount of pumping.
7. Reduces offensive odours.
8. Suppresses green algae.
9. Increases population of zoo plankton.
10. Restores damaged aquatic life.
11. Environmentally friendly.

3.1.1.4 Precautions in MBT method

1. Higher oxygen level - Need to be regularly mix the composting heap, so that, there is enough oxygen available inside the heap. Usually mix the heap every day, or if need the quick degradation, such mixing needs to be carried out twice or thrice in a day.
2. Moisture level of the heap to be 60% at the starting stage. More than 60% moisture level adversely slow down the speed of bio degradation. Less moisture level may blocks the bio degradation as the moisture gets depleted in the middle of the degradation process of MB. If the moisture level of the heap gets quickly lowered due to the higher temperature of the heap, add some water to the heap. You could use the leachate water of the composting heap for this purpose.
3. Supporting temperature to the composting heap - like Korean machine, if you can artificially provide the heat to the composting heap, the speed of the bio degradation gets much faster. The ideal temperature for MB is around 35C to 37C.
4. Always mix with finished compost - because there are good amount of microorganisms present in the well composted organic matter, by mixing the finished compost to the fresh matter helps in fasten the degradation speed.

3.1.2 Operating system 1*dms* (OS1)

The antioxidant substances formed by OS1*dms* in **composting** and **fermentation** of organic matter have the capacity of detoxifying harmful substances. They suppress harmful reactions by deionization of hazardous substances and also promote the chelation of heavy metals such as iron and induce microbes to secrete decomposing enzymes such as lignin peroxidase. Such enzymes have the capacity to decompose residual

agrochemicals and even dioxin in soils. Thus, if OS1*dms* is used with organic matter in soils, which have been heavily contaminated with pesticides or have high concentrations of dioxin, they are detoxified within 2 – 3 seasons. This has been proven in many environments.

When introduced into an environment of anaerobic biodegradation, OS1*dms* rapidly devours the methanogens and toxic pollutants which are formed as a result of the chemical breakdown process. As a result, anaerobic compost piles mixed with OS1*dms* produce no harmful or offensive odors, and decompose very rapidly into pure, nutrient-rich composts, which can be directly infused back into the soil. Unlike conventional aerobic decomposition piles, which require continuous aeration and months of careful attendance, anaerobic piles treated with OS1*dms* have the ability to break down organic waste into compost in less than four weeks.

Composting is the *controlled* decomposition of organic matter. It is the transformation of organic material into a soil-like material called compost. Rather than allowing nature to take its slow course, composting provides an optimal environment in which decomposers can thrive. The most effective decomposers are bacteria and other microorganisms. Some important microorganisms are fungi, protozoa, and actinobacteria (or actinomycetes, bacteria that are often seen as white filaments in decomposing organic matter).

Fermentation is the anaerobic metabolic breakdown of a nutrient molecule without oxidation. It breaks down complex organic compounds into simpler ones which are easily decomposed.

Definition

The process of fermentation of organic matter to detoxifying harmful substances with the help of mother culture is known as OS 1*dms*. The compost obtained by this method is known as OS 1*dms* compost.

3.1.2.1 Culture Details

- Mother culture: - Produces bacteria like Photosynthetic Bacteria, Lactic acid bacteria and Yeast.
- Appearance: Liquid form.
- Dosage: 1liter of M.C. can be used up to 10 MT of organic matter.
- Proportion of mixing: - 1ltr MC: 1kg micronutrients: 50 ltrs water.

3.1.2.2 Advantages of use Mother Culture

1. Reduction in Sludge production: - Sludge is developed due to increase in population of bacterial cells. When the bacteria dies sludge is formed. By adding OS1 the increased population of bacteria eats into the dead cells thereby reducing its volume by upto 70 - 80 %.
2. Reduction in aeration time: - Since these microbes are facultative in nature it is possible to reduce aeration time and save on electricity costs.
3. Reduction in release of foul odour: - Foul odour is released from STPs normally in the forms of H_2S and NH_3. The addition of OS1 in the STP reduces the release of these gasses in the following ways.
4. OS1 breaks down H_2S and NH_3 in the elemental form releasing Sulphur and Nitrogen from the other elements.

Most foul smelling gasses are released by the reaction of pathogens on organic matter. OS1 dominates over these pathogens reducing their population and thus reduces the release of foul odour.

3.3 NATURE AND SCOPE OF PROJECT

This project is eco-friendly and one stroke solution of most of the burning problems like pollution, unemployment, upliftment of rural poor, poor soil fertility, waste land development, poor health, declining yield, more requirement of irrigation of water, more requirement of power and more use of chemical fertilizers and pesticides.

By culture technology we can solve all the problems, total available biodegradable waste can be converted into money that best quality organic manure, employment to unemployed youth and rural poor by establishing projects like MBT and OS1*dms*, improvement of soil structure, porosity and over all fertility of the soil and waste land development by use of humus bio-fertilizer produced by these projects.

The use of chemical fertilizer, pesticides can be reduced in integrated sustainable agriculture and completely replaced in organic farming and healthy more yields can be produced. The irrigation water requirement can be reduced by 50% by improvement of porosity of soil and more rain water absorption is there

and hence underground water table is improved so there is less erosion of upper fertile soil there by reducing the incoming of floods. The power required for irrigation water pumping is also reduced. There for 50% power consumption is saved. The health of soil and plants is improved so the produces like grain, vegetable and fruits are tasty and healthy, so health of labourers. Farmers and consumers is improved. Most of the hazardous diseases like cancer and aids can be eradicated at the grass root level. The use of chemical fertilizers is reduced hence foreign exchange is also saved. The requirement of irrigation water is reduced, so more agriculture can be done in same amount of water.

So the scope of this project is very vast and if it is adopted and supported by the government then organic farming can be done successfully with high yield at low cost, lakhs of the unemployed youth and rural poor can be employed and total biodegradable waste material can be converted into humus bio-fertilizer, so all the cities and villages can become clean and huge sum of money is generated from wastes and prosperous villages can be developed. Hence the economy of the nation can be changed and a clean, healthy, self reliant, prosperous, wealthy and organic nation can built.

It has been estimated that organic resource available in our country can produce about 20 MT of plant nutrients (NPK). The five major crops that paddy, jawar, wheat, bajara and maiz alone are estimated to yield approximately 141.2 MT of straw and legumes add another 10 MT. Futher, the estimated domestic waste is about 25 MT, catal manure 320 MT and poultry manure of 3.3 MT generated annually in India. On the supply demand side the estimated domestic fertilizer production during 2003-2004 is about 14.2 MT as against the consumption of around 17.5 MT living a gap of 3.3 MT which is now mate through import, thus cultural technology as promised potential to meet the organic manure requirements in both irrigated and rain fed area. It had tremendous prospects in converting agro waste and city garbage into valuable agricultural input. This will also provide a safe and clean environment.

IV. PROCESS

4.1 Mechanical Biological Treatment

In this method the main step is shredding or crushing. The shredding or crushing is done by mechanical instruments such as shredding machine, mixers etc. The process of composting or stepwise procedure is as follows: -

1. Collection of waste: - The waste generated in the society is collected through containers as well as from door to door collection of waste is carried out. After collection, the collected waste is dumped in the place where the treatment is to be done.
2. Segregation: - The collected waste is segregated i.e. the bio-degradable and non-biodegradable materials are separated from the complete MSW. For the treatment only bio-degradable waste is taken.
3. Shredding or crushing: - After segregation the bio-degradable waste is shredded or crushed with the help of mechanical means.
4. Adding of saw dust or bagas and mixing of culture: - After crushing or shredding the saw dust or bagas is added to the crushed waste to reduce the moisture content up-to 60 to 70 % approximately. After proper mixing the culture is added in the required quantity and again mix it properly.
5. Placing for curing: - As soon as mixing is complete the waste is placed for curing or for decomposition. The curing is done in brick constructed pits or it can be done in the containers, but care should be taken that there should be enough space to drain off the water from waste. Also for rapid decomposition turning is given to waste so that the process get fasten and the results will be good.

4.2 Operated system 1*dms*

This method does not require any mechanical instruments. But it requires open land to dump the waste in the form of heap. The process of composting or stepwise procedure is as follows:-

1. Propagation: - OS1*dms* MC is propagated at site using Micronutrients (Jaggery), Water and Sunlight in HDPE or equivalent air tight Water Tanks. The propagation takes 7 days to mature depending upon temperature conditions. The propagation is done by a team of trained personnel @ 1: 1: 50 (1ltr. MC: 1 Kg. Micronutrient: 50 ltrs. Water)

2. Collection of waste: - The waste generated in the society is collected through containers as well as from door to door collection of waste is carried out. After collection, the collected waste is dumped in the place where the treatment is to be done. This method does not require segregation at early stage
3. Spraying: - The diluted solution is sprayed over the fresh garbage immediately after it is dumped at the dumping grounds. Spraying may be done in three or more installments.
4. Ragpickers involvement: - Ragpickers are now allowed to segregate recyclables from the mixed MSW. The foul odour is under control and the working environment has improved.
5. Collection in heaps or windrows: - After the ragpickers have performed their service the garbage is gathered together to form heaps or windrows and left for 30 to 45 days for decomposition to take place.
6. Spreading and compaction: - The decomposed mixed matter is then spread and compacted using suitable machines such as J.C.B.'s, bull dozers, etc. in the land fill area.

V. CASE STUDY

These methods are applied for the various locality for the treating the kitchen waste. The waste samples of green waste and kitchen waste each are collected separately in random manner. The wastes were collected from the college hostel mess, canteens, hotels etc. and green waste from market, which comprised of different left over putrefied vegetables such as cabbage, cauliflower, carrot, brinjal and leafy vegetables. These wastes were characterized by segregating and discarding the non-biodegradable fraction and the biodegradable component was used for study. The results of this study are as follow.

1. Amount of Manure obtained and Time Consumption

Sl. No.	**Method**	**Time consumed in days**	**Amount of manure obtained in percentage**
1	MBT	16	20.37
2	OS 1 *dms*	29	8.35

2. NPK and other Nutrients obtained in manure

Sl.No.	Nutrients	MBT	OS 1*dms*
1	pH	7.96	5.85
2	EC	260	1079
3	Total N	2.15%	2.92%
4	Total P_2O_5	0.82%	1.16%
5	K_2O	2.11%	2.32%
6	OC	53.92%	51.04%
7	C:N	25.07:1	17.47:1
8	Zn	60 ppm	180 ppm
9	Cu	0 ppm	20 ppm
10	Fe	300 ppm	300 ppm
11	Mg	0.18%	0.32%
12	Ca	0.80%	1.20%
13	B	0 ppm	620 ppm
14	S	0.14%	0.62%

In the present study it is found the manure obtained from MBT is better as compared to OS 1dms because it has a pH range of 7.96, C:N ratio of 25.07:1 & Nitrogen content of 2.15% which are the within the desirable parameters for increasing the yield of crop & maintaining the fertility of soil.

In MBT method the waste is crushed, hence the microbial activity is more. Due to turning process good aeration takes place, so the decomposition is faster. Hence the amount of manure is more.

In OS 1*dms* the main use of this manure is for land-filling so the amount of manure obtained is less. As there is no crushing and no turning the less aeration takes place.

Comparing the nutrients of compost obtained from MBT and OS1*dms* it was found that the manure of MBT waste possessed significantly higher concentrations of the nutrients which are required for good growth of plants than that of OS1*dms* manure. The amount of humus in MBT is more followed by OS1*dms*, as well as the time consumed for MBT is less than the OS1*dms*.

VI. CONCLUSION

1. The MBT and OS 1*dms* methods can be successfully decompose the vegetable & kitchen waste and converted into useful eco-friendly manure.
2. The compost strength is mainly decided by three parameters viz. pH, N & C: N ratio. By comparing the nutrients the MBT method has found the significantly higher concentration of nutrients which is good for the growth of the plants. Hence the manure obtained by the MBT is richer in comparison with the OS 1*dms*.
3. As the good aeration takes place in the MBT method the waste decomposes early & the quantity of manure obtained in this method is more than OS 1*dms.*
4. The initial investment is high for the MBT method as the shredding machines are required; but it proves more economical in future as the recycled material is more compared to OS 1*dms* method.

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