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Investigation of Physical Parameters Influencing Composting Using Effective Micorobe's

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Abstract: Waste management and treatment is one of the biggest problems in the world. Around 50% of the waste in the world is organic in nature. Household waste is one among them. Many innovative technologies have been reported in solid waste management and research is still going on. Composting is considered as an acceptable technology for biodegradable waste management all over the world. The influence of physical parameters such as pH and temperature were studied. It was observed that there was significant influence of EM solution in the decomposition and accelerators at controlled conditions were contributing to fast composting

Effective Microbial (EM) Technology is a natural and probiotic process carried out by using microbial culture consisting of beneficial and highly efficient microorganisms that are non-toxic and non-pathogenic. The objectives of this projects also include identification of the best accelerator to promote fast composting. Studies were conducted to identify the physical parameters influencing composting using effective microbes.

Keywords: Composting, household waste management, EM technology, organic waste utilization, inoculums.

I. INTRODUCTION

Waste poses a threat to the public health and the environment if it is not managed properly. Household waste accounts a major portion of municipal solid waste and its effective disposal is the need of the hour. India generates 62 million tons of waste every year, of which less than 60% is collected and around 15% is processed (H.Jouhara et al.,2017).The bio degradable component of India's solid waste is currently estimated at a little over 50%.The problem of domestic waste is drawing attention of the people as huge garbage is lying down uncollected beside roads, streets or dustbins on the ground, which is causing threat to the environment as well as endangering public health. These wastes are often generated as consequences of household activities such as cleaning, cooking, etc. While focusing on Kerala, it is found that, on an average of 6000 tons of solid waste is being generated which includes 49% of household wastes alone (H.Jouhara et al.,2017). While questioning the reason behind this rapid increase in waste it is found that the rapid urbanisation, constant change in consumption pattern and social behaviour have increased the generation of Municipal Solid Waste (MSW) in Kerala beyond assimilative capacity of our environment and management capacity of the existing waste management systems. It is necessary to look into the available data on the quantity and character of MSW generated at various parts of the state for planning further studies on the aspect.

Solid waste management is a major challenge worldwide due to the rise in population and industrialization, leading to larger amount of solid wastes being generated. Composting can be a viable alternative of organic waste utilisation in the developing countries due to low cost. Its potential for environmental sustainability, cost effectiveness and public acceptance is relatively well known. The practice of composting at home can be hindered by a lack of knowledge and technique to manage. Different composting system, process parameters, input materials and its formulation, and the environmental condition will result in a variation of compost quality.

Composting can be defined as an anaerobic, biochemical and microbial process that implicates the hydrolysis of organic fraction into stable and sanitized residue; humus. Here in microbes carry out the decomposition of organic matter by utilizing carbon and nitrogen as the energy sources along with oxygen and water, ensuring the production of water, carbondioxide, heat, and soil-enriching compost. The derived compost possesses a significant concentration of biologically stable humic substances, acting as excellent soil amendment. During the process a spontaneous rise in temperature, helps to eliminate the pathogens, making the generated compost safer for use.

The most eco-friendly and safe technology that can be used for composting is EM technology; Effective Microbial (EM) Technology is a natural and probiotic process carried out by using microbial culture consisting of beneficial and highly efficient microorganisms that are non-toxic and non-pathogenic.EM or effective microorganisms are microbial inoculant containing many kinds of naturally occurring beneficial microbes (Fan etal,2017). These include photosynthetic bacteria, Lactobacilli, yeast, fungi and actinomycetes. The dynamics or succession of a microbial community within composting, reflects their degradative capacity for compost mix. Along the process, variations produced in a microbiome depend extremely on composition of the raw materials and nutrient supplements, environmental conditions (ambient or trial) and interactions among all these factors. Here in, Bacteria

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and fungi are the most abundant and fastest emerging microorganisms during composting. The substrates utilized and the microbiota involved within the process have a great influence on the quality of the formed compost. They promote organic degradation within composting by releasing various substrate based hydrolytic enzymes that break the complicated structured molecules, forming water-soluble compounds. Besides metabolizing the organics, they produce simple usable compounds that enhance the agricultural possibilities and stabilize the natural ecosystem when added to soil. An initial trend showed an expected decrease in the microbial biomass, associated with changes in C/N ratio and temperature of the composting mass.

At mid mesophilic stage of composting, bacterial population continued to proliferate with production of more enzymes that resulted in proper humification (add in lit review). Finally, microbial mass underwent a gradual decline at the cooling or maturation phase of waste composting. Generally, the fungal abundance observed throughout the process was lower compared to the bacterial population. Certain modifications in the process integrating, bulking agents as addons to the substrate (such as rice husk, saw dust, wood chips and others) can develop an efficient microbiota. This would further optimise the C/N ratio and retain quality of a compost. EM decrease pH, inhibits pathogens, fix and utilize CO_2 and H_2S provided. Inoculum containing EM is often added in powder form or solution form. EM technology acts as an important and beneficial tool for maintaining and carrying out degradable waste management. EM has a number of applications including agriculture, livestock, gardening, composting, bioremediation, etc. EM along with accelerators gives appreciable results in composting. As it helps in plant growth, it is necessary to check the quality standards like NPK test

II. LITERATURE REVIEW

Many researchers have investigated the effectiveness of bioreactors for degradation of large quantity of food waste and slaughter waste. Composting is a viable alternative of organic waste utilization in the developing countries due to its low cost . Its potential for environmental sustainability, cost effectiveness and public acceptance is high. Richard (1992) carried out a study that reviews the variety of processing systems available, with particular reference to innovations which can enhance the production of MSW compost. The ideal raw material for a compost product is clean organic waste. The key environmental parameters are the available carbon to nitrogen (C: N) ratio, moisture, oxygen, and temperature. Carbon and nitrogen are the two most important elements in the composting process, as one or the other is normally limiting. Carbon serves primarily as an energy source for the microorganisms, while a small fraction of the carbon is incorporated in their cells. Nitrogen is critical for microbial population growth, as it is a constituent of protein which forms over 50% of dry bacterial cell mass. Management of household waste through small scale composting is the most effective method of organic waste management. Mathews and Gowrilekshmi (2016) have done research to accelerate the degradation process by addition of microorganisms into the food waste. It was reported that Effective Microorganisms (EM) have the capacity to accelerate the composting process. EM is regarded as mixed liquid culture of microorganisms that "work together with the beneficial in the area to which it is added, creating a synergy among microorganisms and larger forms of life". Main species of EM microorganisms: Lactic acid bacteria - *Lactobacillus plantarum, L. Casei, Streptococcus lactis,* Photosynthetic bacteria, *Rhodopseudo-monas palustrus, Rhodobacterspaeroides,* Yeasts - *Saccharomyces cervisiae, Candida utilis,* Actinomyces - *Streptomyces albur, S. griseus,* Fermenting fungi – *Aspergillusoryzae, Mucorhiemalis.* H.Jouhara et al., (2017) studied about municipal waste management systems for domestic use. In their studies, they explained the optimum condition for composting. The C:N ratio to ensure effective decomposition is about 30 part carbon to part nitrogen by weight. Excessive aeration will cause a temperature drop and great loss of moisture by evaporation, causing the decomposition process to stop. pH of composting material should be maintained at 5.8 to 7.2.Too low temperature (below 35degree Celsius)may caused by insufficient moisture or a nitrogen deficient in the composting material and too high temperature (above 70degree Celsius) can be caused also insufficient moisture or ventilation.

Fan et.al (2017) carried out a study aimed to evaluate the effect of Effective Microorganism (EM) for the home scale co-composting of food waste, rice bran and dried leaves. The composting was carried out with or without EM (control) to identify the role of EM. Rastogi et al,(2020) describes the vital role of microbes for solid waste composting. The use of microbial activities during composting is considered highly efficient, likely to enhance the production of different enzymes resulting in better rate of waste degredation. They explained that Composting is the most extensive applicable process to manage these wastes particularly in case of Indian genera, where 50–60% of MSW (C/N ratio 23) collected is biodegradable. H.Jouhara(2017) carried a study that reviews the available waste management systems for households. Several factors are noted in composting like agitation, aeration and mixing of the compost, to produce uniform organic fertilizer without any odour or leachate related problems. Some factors have been identified as important for aerobic microorganisms to work properly. The speed of compost generation is the result of attention paid to these factors. Nevertheless, meat, fish, dairy products and sanitary material are to be avoided because they are likely to attract vermin. The addition of meat waste as feedstock for composting in bins increased the temperature during aerobic decomposition. During the maturation phase the temperature drops to ambient. It is desirable that the temperature does not drop too fast, since the higher the temperature and the longer the time, the higher the decomposition rate and the achievement of a hygienic compost. Too low a temperature (below 35 °C) may be caused by insufficient moisture or a nitrogen deficit in the composting material and a high temperature above 70 °C) can be caused also by insufficient moisture or ventilation Both too low and too high temperatures cause the death of the desired group of microorganisms.

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III. METHODOLOGY

A. Materials used

The preliminary composting phase was performed just as a representation of vegetable wastes selected by an ordinary house maker. The vegetables consisted of pumpkin, Raw Banana, Onion, Orange and Tomato total accounting to a cumulative weight of 1.5Kg in each bucket (Table 1). All vegetables were chopped into pieces of roughly 1cm cubes for uniformity. All the five buckets were filled with 1.5kg of vegetable waste having the same composition and each of these buckets were labelled as sample1, sample 2, sample 3, sample 4, and sample 5.

Accelorators and innoculum: EM solution is collected from VFPCK-Vegetables and Fruits Promotion Council Kerala, Alathur, Palakkad. Rice water and Jaggery are taken as accelerators for the composting processes.

Table 1 Proportion of vegetables used to produce compost buckets

VEGETABLE USED	SAMPLE WEIGHT
Pumpkin	300gm
Raw banana	300gm
Onion	300gm
Tomato	300gm
Orange	300gm
Total	1.5Kg

B. *PRELIMINARY COMPOSTING*

A preliminary composting was performed in specially designed buckets to understand and visually observe the method of composting and all the stages involved (Fig 1).Five buckets having 6kg waste capacity provided with coir bed and a leachate collection system are used. Natural aeration is provided. Wire mesh lids were provided to prevent the menace of rodents and also to ensure sufficient aeration. All the samples were agitated with a wooden rod at an interval of 24hrs.

Table 2 Details of inoculum and accelerators added

BUCKET	VOLUME OF INOCULUM (ml)
Sample 1	75ml
Sample 2	100ml
Sample 3	75ml with 100ml rice water
Sample 4	75ml with 100gm jaggery
Sample 5	Nil condition

Physical characteristics of the compost were noted and the bucket having maximum bacterial activity and shorter compost duration was noted down. The physical nature of compost like colour, temperature, smell and moisture content were observed directly at regular intervals. The physical changes in compost were observed in every 5 days.

Table 3. Physical properties of Compost samples after 5 days

SAMPLE NO	COLOUR	TEMPERATURE	SMELL	MOISTURE
1	BROWN	27	SLIGHTLY FOUL SMELL	MEDIUM
2	BROWN	27	SLIGHTLY FOUL SMELL	MEDIUM
3	BROWN	27	SLIGHTLY FOUL SMELL	MEDIUM
4	BROWN	27	SLIGHTLY FOUL SMELL	MEDIUM
5	BROWN	27	SLIGHTLY FOUL SMELL	MEDIUM

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Fig. 1. Compost Sample (No 5) after 20 days

Observation on 5th day showed no variation in any physical characteristics in compost. The colour of compost remained relatively brown & no remarkable heat formation was noted. Slight foul smell combined with medium moisture content was noted (Table 3).

During the observation in the second week, sample 3 which had EM solution and rice water as accelerators have shown faster stabilisation. The raw sample kept in Samples 5 was still not stabilized (Fig 2). By the end of 20 days all the buckets containing the 1.5kg of the waste, except Sample 5, have completed composting. Table.4 shows the properties of all samples at the end of 20th day. Composts were collected and packed in different covers. NPK value of the compost was tested and the result showed that the sample was having good manure value.

Table 4. Physical properties of Compost samples after 20 days

SAMPLE NO	COLOUR	TEMPERATURE, °C	SMELL	MOISTURE
1	BLACK	30	NIL	VERY DRY
2	BLACK	31	NIL	VERY DRY
3	BLACK	32	NIL	VERY DRY
4	BLACK	32	NIL	VERY DRY
5	50% BLACK FORMATION	28	NIL	DRY

The NPK Value indicates what is the amount (mass percentage) of the three major components in plant nutrients .The NPK value stands for nitrogen, phosphorous and potassium. Nitrogen is necessary for the growth of plant. Phosphorous promotes the formation of roots and development of buds and flowers. Potassium ensures a strong plant, improves the resistance and protect the plant from possible infections.

The comparison of the results shows that the manure obtained as a result of the experimental study has much more nutrient value than the manure produced by the conventional composting carried out at IRTC, Palakkad.

ITEM	SAMPLE MANURE OBTAINED AFTER COMPOSTING (%)	MANURE PRODUCED BY IRTC (%)
Nitrogen	2.84	1.26
Phosphorous	0.42	0.06
Potassium	2.61	1.2

Influence of temperature on composting

Microorganisms generate heat as they work, thus compost begins at ambient temperature that can increase to 65°C with no need of human intervention. It is desirable that the temperature does not drop too fast, since the higher the temperature and the longer the time, the higher the decomposition rate and the achievement of a hygienic compost. Too low temperature below 35°C may be caused by insufficient moisture in the composting material and too high temperature above 70°C can be caused also by insufficient moisture or ventilation. Both too low and too high temperatures cause the death of the group of microorganisms.

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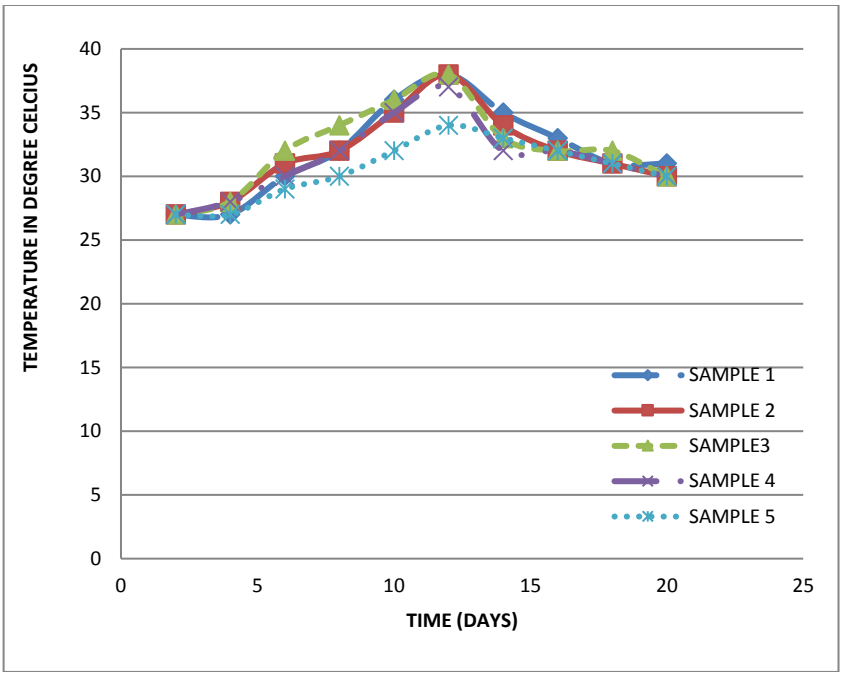
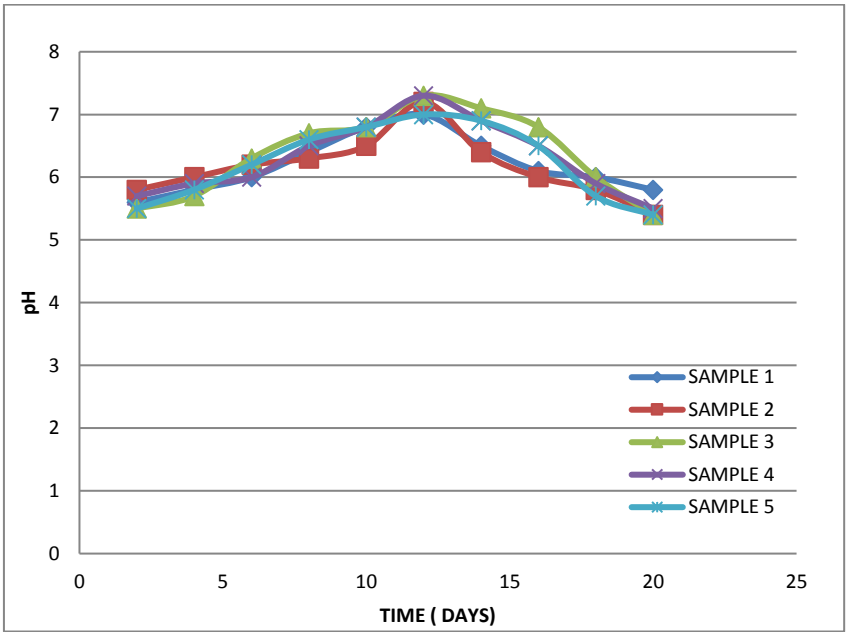


Influence of pH on composting

The pH of the composting material should be maintained at 5.8 to 7.2



IV. CONCLUSION

The quality and stability of compost is entirely dependent on its raw materials (Wang et al. 2004). During the composting process, various parameters including the C:N ratio, composting temperature, pH of the finished product, moisture content, and the presence of potential bacteria are used to assess the quality and stability of the compost. The study was performed to treat domestic wastes generated at household by the method of composting using effective microbial technology. It was observed that, under the laboratory condition of 40° C and C/N ratio 30,100ml inoculum was found as optimum for treating 1.5 kg of vegetable sample within shorter duration. Microbial activity was found to be greatest during the thermophilic phase where the decomposition of organic matter takes place at its peak level. Rice water was found to be the best accelerator than other similar accelerators when used with optimum amount of inoculum and same experimental condition.

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