BIODEGRADABLE WASTE TREATMENT WITH ADDITIVE BASED COMPOSTING : A REVIEW

Prathamesh Gurme[1] Dr. R. P. Borkar[2]

PG Scholar[1] Professor[2]

(Department of Civil Engineering and Applied Mechanics)

Government College of Engineering, Amravati, Maharashtra.

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ABSTRACT :

The Growing world population and the resulting higher consumption of products and services has driven a rapid increase of organic wastes originating from households, industry and agriculture. This situation generates serious environmental issues, calling for safe and sustainable strategies to treat these wastes, from their production to their recycling or elimination. On the other hand, the organic fraction of wastes represents a valuable organic resource, which could be recycled and transformed into nutrient-rich fertilizer and/or soil conditioner. Biological degradation during composting is one of the strategies to transform organic wastes into organic products. Composting is a time consuming process [1] including degradation of waste by the microbial population

converting them into a stable organic fertilizer. Hence, a considerable research in the field of rapid composting is to be done so as to accelerate the composting process. The different authors had discussed the methodologies used previously and gave outline of some *modified technologies. This review is summarized from study of literature regarding composting process highlighted in various journals, papers, relevant text books, relevant websites and proceedings of national and international conferences. It describes the best and optimum additives as well as techniques enhancing the composting process by reducing the period of composting and hence achieving rapid composting. The purpose of this review is to get an overview of current approaches related with rapid composting and other treatment techniques which were used for normal composting so that various suitable techniques can be merged in combination in order to generate a new technique which will be beneficial for reducing the duration of composting.*

KEYWORDS : Additives, Bioculture , Biodegradable, Rapid Composting

1. Introduction :

The world of 21st century is concerning about environmental and socio- economic problems in dealing with current and future management and planning of waste disposal. The waste produced in urban areas of India is approximately 170 thousand tonnes per day, equivalent to about 62 million tonnes per year, and this is expected to increase by 5% per year owing to increases in population and changing lifestyles. With changing consumption patterns and rapid economic growth, it is estimated that urban municipal solid waste generation will increase to 165 million tonnes till 2030. The vast amount of industrial, municipal and agricultural wastes has led increasing pressure on environmental, social and economic problems. Stringent environmental regulations for waste disposal and landfills make finding new sites for waste disposal and management a growing challenge. Solid waste management requires the application of effective strategies for proper wastes disposal and treatment . major part of these wastes in India consists of biodegradable organic material (50–55%). We can recycle and dispose them through the economic and ecofriendly technique of composting. Composting as a method for preparing organic fertilizers is ecologically and economically helpful and may well represent an acceptable solution for disposing of municipal solid waste. Normally, composting is a labor intensive and time consuming process which makes it unattractive for adopting at large level . Thus, rapid composting is “essential” as it reduces significant period of composting and providing more stable compost, with the supplementation of nutrient. It is noted that no universal method for composting as the types of substrate and its physio-chemical condition can influence the process. Advancements in composting process control will help increase the efficiency and economic suitability of the related technologies, and thus contributing to agricultural and environmental sustainability .

2. The composting process :

Composting can be defined as it is the natural process of decomposition of organic matter by micro-organisms under controlled conditions. Raw organic materials such as crop residues, animal wastes, food garbage, some municipal wastes like garden waste and suitable industrial wastes, enhance their suitability for application to the soil as a fertilizing resource, after having undergone composting . It is the process in which aerobic microorganisms converts organic matter into hygienic, bio stable product by thermophilic.This natural process is affected by some environmental conditions like temperature, moisture content, pH and aeration and substrate characteristics like C/N ratio, particle size, nutrients contents and free air space. During degradation of organic matter, moisture content influences the changes in physical and chemical properties of waste material. Compost is a rich source of organic matter. Soil organic matter plays an important role in sustaining soil fertility, and hence in sustainable agricultural production.

3. Composting using additives :

Additives to be used for composting are meant to enhance microbial activity when the additive is in contact with the waste material during the initial stage of composting process. As a result the degradation of the waste occurs at increased rate achieving rapid composting. Various new additives can be determined by experimentation based on materials facilitating the rapid growth of waste degrading microbes, increasing temperature during composting, enhancing aeration throughout the composting material by using porous additives, etc. Similarly, two different types of wastes can also be combined in order to accelerate the composting process. Additives are basically a mixture of various microorganisms, nutrients or readily available forms of carbon, enzymes, etc. which enhances the microbial activity when the additives are in contact with the organic waste. The addition of commercially available bio-culture containing effective microorganisms can assist in production of good quality compost. A commercial available microbial inoculum containing EM when used as an additive changed the temperature profile of the composting process and the ammonia emissions due to the increase in the mesophilic and thermophilic bacteria.

Utilization of jaggery and polyethylene glycol favored composting process as by acting as food for the waste degrading microbes. Addition of lime showed a positive effect on composting process by increasing the temperature and CO_2 evolution without any negative effect on microbial community . Fly ash has water holding capacity due to high porosity which maintains the moisture content required for composting process . Ash increased the rate of mineralization of compost and the formation of humic acids. The compost with Effective Microorganisms (EM) has shown a few significant beneficiary impacts including the improvement of odour control and few parameters (humification process, fat reduction and N content). Various studies have been carried out previously, clearly indicating the utilization of additives could be beneficial for the composting process. .

4. Discussions :

Composting is an aerobic, or oxygen-demanding, degradation of organic matters by microbes in precise conditions. Although composting is a biological process, it is controlled by many physicochemical parameters. Some of the most influential composting parameters are: Temperature, pH, aeration, moisture, size, nature and volume of substrate, C/N ratio etc. They are illustrated in following table 4.1.

Table 4.1 : Factors affecting composting and their Ranges

FACTORS AFFECTING COMPOSTING	RANGES		
	ACTIVE	**CURING**	**PRODUCT STORING**
Oxygen Concentration	**13 – 18 %**		
Free air space	**40 – 60 %**		
Particle size distribution	**Mixture of particles between 3 – 50 mm**		**Min. 90 % material passing through IS sieve**
Structure	**Enough of particle in composting pile maintaining their structural properties throughout composting process**		
C/N Ratio	**25:1 – 30:1**	**18:1 – 23:1**	**15:1 – 20:1**
Moisture Content	**55 – 65 %**	**45 – 55 %**	**15 – 25 %**
Temperature	**55 – 60 °C**	**Less than 50 °C**	**Ambient**
pH	**6.5 – 8**		**6.5 – 7.5**

There are different methods for composting are developed and were used all over the world according to extent of type of waste and available infrastructure to compost. Following table 4.2 showing comparison between various aerobic composting technique used in fields.

Table 4.2 : Comparison of different Aerobic Composting Methods

METHODS ADOPTED	SIZE REDUCTION	TURNING PERIOD (in Day)	DURATION FOR COMPOSTING
Indore Pit Composting	--	15, 30, 60	4 months
Indore Hip Composting	Shredded	42, 84	4 months

Chinese Pit Composting	--	30, 60, 75	3 months
Chinese high Temperature Composting	Shredded	15	2 months
Ecuador on-farm Composting	--	21	2-3 months in summer and 5-6 months in winter
Berkeley Rapid Composting	Shredded to small size	Daily or Alternate day turning	2 week with daily turning and 3 week with alternate turning
North Dakota State University Hot Composting	Shredded	3 or 4	4 - 6 week
EM based Quick Composting	--	14, 21	4 - 5 week
IBS Rapid Composting	Shredded	7, 14 then every 2 week	3 – 7 week

The popularity of composting led to a high demand on the market for composters of various scales as well as compost-related products, such as bulking materials and compost accelerators that are supposed to improve the process and the quality of compost. There are various Compost Activator or Enhancer are available commercial and more and more research are going on to find out different additives to get rapid composting for every type of waste. Following table 4.3 has illustrated comparison among different additives used by researchers and proposed effectiveness on treatment of wastes.

Table 4.3 : Different additives used by researchers

NAME OF AUTHORS	TYPE OF WASTE ANALYSED	ADDITIVES USED	REMARKS

GHABHANE JAGDISH (et. Al. 2012)	Green Waste	Jagger, Fly Ash, Phospogypsum, Polyethylene Glycol, Lime	1. Jaggery and PEG treatment were better other treatments. 2. Jaggery enhanced composting through increasing microbial biomass and stimulate enzymatic degradation and quality of final compost.
GABHANE JAGDISH (et. Al 2019)	Green Waste, Rice Waste, Wheat Straw, Garden Waste, Sawdust	Jaggery (2%), PEG(0.25%), Peptone(0.25%), Spores of Trichoderma viride, Trichoderma reesei, phanerochaete crysosporium	1. Addition of Compost Activator decrease time of composting. 2. Thermophilic phase is essential for composting like it reduce duration.
MANASI RASTOGI (et. Al 2019)	Municipal Solid Waste	Cow dung and Cellulolytic Bacteria	1. Role of temperature is intensified microbial activity and accelerated compost maturation. 2. This facilitated early maturity to other treatment.
PAYAL SHRIRAO (et. Al 2020)	Organic Waste (Garden Waste)	Combination of Jaggery Powder, Cowdung, Wheat bran, Sawdust, Eggshell powder, Sugarcane	1. Accelerators prepared from natural ingredients is feasible

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		bagasse, Lime, Coconut coir power, Neem leaves, Used tea power	product and has potential to commercialize. 2. It can reduce cost, time duration and increase compost quality.
ROSHAN MANKHAIR (et. Al 2020)	Garden Waste	Jaggery Lime Fly ash Bio culture	1. Bio culture and Jaggery are additive suggested for rapid composting. 2. Jaggery and fly ash contains carbon source helpful for microbial activity.

As mentioned in above table, past research literature has shown usage and effectiveness of various additives is helpful in composting treatment. These different additives has several characteristics and benefits as stated in following table 4.4

Table 4.4 : Characteristics and usefulness of Different additives

NAME OF ADDITIVES	AUTHOR	REMARKS
JAGGERY	Jang (2002) Raut (2008)	Swiftly Boosted growth of microbes leading microbial metabolism

	Rao (2007)	High calorific energy substrate for microbes and sufficient amount of nutrients & vitamins.
	Gabhane (2012)	It has increased rate of organic matter degradation and increase in temperature
	Roshan Mankhair (2020)	Increased no. of microbes thus enhance degradation of cellulose during composting
	Payal S. (2020)	It improve Potassium content
LIME	Wong & Fang (2000)	Positive effect on increasing temperature and CO2 evolution without negative effect on microbial activities
	Rao & Radhakrishna (2008) Roshan Mankhair (2020)	Contains vital nutrients for microbes growth but could not increase biomass due high pH
	Gabhane (2012)	Don't change temperature profile so indicates don't affect microbial biomass
FLY ASH	Belyaeva & Haynes (2009)	It can decrease thermophilic phase by increasing capacity of water holding
	Rao & Radhkrishna (2008) Zang (2017)	Contains high nutrients for microbes growth
	Roshan Mankhair (2020)	Due to high porosity and water holding capacity enabled maintain moisture content
COWDUNG	Payal S. (2020)	Regulate carbon content, bulk density, pH

5. Conclusion :

This literature study gives the idea about the whole composting process i.e. Composting being a slow process involving biological waste stabilization makes unattractive for implementation. It has been recognized that there is no single , simple solution to deal with solid waste problems. Instead, an integrated approach, combining the elements of multiple techniques, is to be used in current research. The study suggested that various additives can be utilized during the initial stage of composting in order to influence the composting parameters (pH, temperature, moisture content, etc.) favorable for rapid composting process. The additives also stimulate the growth of waste degrading microbes and enhance the enzymatic activities. There are no. of additives material and ingredients has been used by many researchers to get optimum result in treatment with Jaggery, Fly ash, Lime, Cow dung, Polyethylene Glycol, Phospogypsum, Peptone Spores of bacterial, Wheat bran, Eggshell powder, Sugarcane bagasse, Coconut coir, Wooden ash etc. individually or in combination in interest of researchers. Certain additives due to their porous nature facilitate proper and improved aeration in compost piles. Certain techniques like aeration, periodic waste turning, shredding of the bulky raw waste are also found to be effective in accelerating the composting process. The additives containing minerals also increase the nutrient content of final compost though the initial feedstock are not nutrient rich. Hence, the utilization of various additives and techniques lead to the accelerated composting process and the final compost has higher nutrient content.

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