JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

APPLICATION OF VEGETABLE WASTE TO MAKE COMPOST TEA USING BIN COMPOSTING TECHNIQUE WITH ADDITIVES - A REVIEW

[1]Rohini D. Giri, [2]Dr. M. N. Hedaoo
[1]Post Graduate Student, [2]Associate Professor
[1]Civil Engineering Department,
[1]Government College of Engineering, Amravati, India

Abstract : Currently India is the world's third largest garbage generator and by the year 2050 the waste generation is expected to go up by 436 million tones thus turning India into one big garbage dump. With rapid urbanization, the country is facing massive waste management challenge. Over 377 million urban people live in 7,935 towns and cities and generate 62 million tonnes (MT) of municipal solid waste per annum. Only 43 million tonnes of the waste is collected, 11.9 MT is treated and 31 MT is dumped in landfill sites. Solid Waste Management (SWM) is one among the basic essential services provided by municipal authorities in the country to keep urban centers clean. However, almost all municipal authorities deposit solid waste at a dump yard within or outside the city haphazardly. The increase in waste generation as a by-product of economic development has led to various environmental issues. Energy-from-waste is a crucial element of SWM because it reduces the volume of waste from disposal, also helps in converting the waste into renewable energy and organic manure. Thus installation of waste-to-compost units would reduce the load of landfill sites.

The biodegradable component of India's solid waste is currently estimated at a little over 50 per cent. It is believed that if we segregate biodegradable waste from the rest, this itself could reduce the challenges by half. In India, disposal of vegetable market waste along with municipal solid waste in landfills or dumpsites is creating much nuisance in terms of odour nuisance, leachate production, and greenhouse gas emission into the atmosphere. Therefore, vegetable waste with high biodegradable and nutrient content needs to be properly disposed. Food waste represents almost 60% from the total municipal solid waste disposed in the landfill. Disposal of vegetable waste, which contains about 60- 80% of moisture to the landfills, causes various problems like easy putrefaction, offensive odour and pollution of ground and surface water by leachate. Due to interruption of the carbon cycle by disposal of waste to landfills, organic vegetable waste requires proper composting system to reduce its uncontrolled degradation on disposal sites and subsequent greenhouse gases, odour and nutrient emissions.

We know that composting is a time consuming process & it requires a specific period of time for the compost to mature completely so that it can be used as organic manure. But with growing population & needs it is necessary to find alternatives, to speed up the process of composting. Also with changing needs & to get maximum benefits, there is a need to change the year's old method of using traditional compost for agricultural purpose. Here comes the idea of using compost tea instead of traditional compost. Compost tea is defined as filtered products of compost brewed in water and brewing, a steeping process of compost in any solvent (usually water), which lasts for more than one hour (National Organic Standards Board 2004).

Thus there is a need to contribute towards the identification of a system for managing & utilizing vegetable waste for sustainable agriculture use by treating the vegetable waste to produce compost & compost tea.

Index Terms **- Compost tea, bin composting, MSWM, additives, bulking agents.**

I. INTRODUCTION

India is turning into one big garbage dump. Urban India is the world's 3rd largest garbage generator and by 2050 waste is expected to rise to 436 million tonnes up. Around about 10 million tonnes of garbage is generated in just the metropolitan cities alone like Delhi, Mumbai, Chennai, Hyderabad, Bangalore and Kolkata. Out of the total municipal waste collected, 94% is dumped on land and 5% is composted. Central Pollution Control Board in its report which was released in 2009 indicates that around 62 million tonnes of solid waste is produced in our country every year, of which less than 20% or only 12 million tonnes are treated. This essentially means that the remaining 52 million tonnes of waste remain 'untreated' and contaminate land or make its way into rivers, lakes and wetlands. Another major issue is the overflowing landfills – there is literally no space to accommodate fresh garbage waste. An expert at the Centre of Science and Environment says, instead of constructing new landfill sites, the government should be really looking into innovative methods to dispose and recycle its waste. The reason why most landfill sites are over-

flowing is because the current waste disposal system is flawed. Nearly 20% of methane gas emissions in India is caused by landfills. The trash dumped in the landfills is prone to catching fire due to the heat generated by the decomposition of waste. According to a study done by scientists at the School of Environmental Sciences in Jawaharlal Nehru University, high levels of nickel, zinc, arsenic, lead, chromium and other metals are part of the solid waste at landfills in many metro cities, especially in Delhi. In today's world there are concerns with accumulating waste, limited amounts of freshwater and fossil fuels, decreasing biological diversity, and world hunger [4]. In addition, vegetable waste may be wasted if it is just dumped to landfills as it will break up naturally and never be used directly again, having its nutritious matter lost within the waste [5]. The handling and utilization of vegetable waste has become a major environmental issue. In India, the amount of vegetable waste generated has increased significantly in the last few decades due to the rapid population growth and economic development in the country. Amongst the various treatments available for waste disposal such as sanitary landfilling, incineration, pyrolysis & composting, composting proves to be most safe for environment.

Composting can be defined as a biological process through which microorganisms convert organic materials into useful end products, which may be used as soil conditioners or organic fertilizers [6] or in other words we can say , compost is a broad term that can be defined as the product resulting from the controlled biological decomposition of organic materials, occurring under aerobic or anaerobic conditions with adequate moisture and temperature, sanitized through heat generation and stabilized to the point that it is appropriate for its particular application.

The bin composting reactor requires small area for installation and operation which is essential in the densely populated country like India. The problems of fly breeding, odour generation, and rodents are eliminated because of the enclosed aerobic design of the composter. This method produces compost in just a few weeks thus taking comparatively lesser time than conventional composting methods. To curb such a huge amount of waste, the composting process must be rapidified and it can be achieved by using bin composting technique along with additives & bulking agents [7]. Various substrates that might be added to waste during the composting process to speed up the composting process are known as additives. Some added substrates are considered as bulking agents, when they only act on the physical structure of the compost (aeration), but most of the time, these substrates have also direct or indirect effects on other composting parameters and can be considered as additives. In other words, bulking agent is a carbon-based material that adds structure (or bulk) to your compost pile. Classic examples include: wood chips, wood shavings, saw dust, dry leaves, shredded landscape waste, shredded paper, shredded cardboard and animal bedding. Additives are used to enhance the composting process by reducing leaching and gas emissions, improving compost aeration or accelerating organic matter degradation and improving nutrient content and availability in the final product [8].

II. COMPOST TEA

Compost tea is defined as filtered products of compost brewed in water and brewing, a steeping process of compost in any solvent (usually water), which lasts for more than one hour (NOSB 2004) [3]. In recent years, the use of the water extract from fermented compost (compost tea) has become popular. Its use has been promoted as way to provide nutrients and biological benefits to plants and soil. Most reported studies involving the use of compost tea have been performed on agricultural crops, such as corn, bean, lettuce, tomato and potato for disease suppression. Compost teas contain a significant quantity of total nutrients with the majority being primary macronutrients. Secondary and micronutrient concentrations are more variable, but contents are generally insufficient to satisfy crop requirements. Noting this, compost tea use in agriculture supports crop nutrition directly and indirectly. Improvements in soil quality have been widely reported for a range of soils and compost teas. A key feature of compost tea amended soils is the increase in soil organic matter and microbial diversity and its associated benefits [9].

Until recently compost tea has been defined simply as a liquid extract from composted material that may contain organic and inorganic soluble nutrients, and a large number of organisms including bacteria, fungi, protozoa and nematodes. However contemporary proponents of compost tea use now distinguish compost teas on the basis of production (or brewing) method, which influence tea characteristics and potential benefits. The following expressions are now commonly used to distinguish between different types of liquid extracts:

Compost leachate is the dark coloured solution that leaches out of the bottom of the compost pile (compost windrow leachate). This leachate is most likely rich in soluble nutrients, but in the early stages of composting it may contain pathogens. Thus compost leachate needs further bioremediation and is not suitable as a foliar spray.

Compost extract is a filtered product of compost mixed primarily with water but not brewed or held for more than one hour before use. [3]

Compost tea is a compost extract that is brewed with or without a microbial food source (such as molasses, kelp, rock dust, humic-fulvic acids and others). The compost tea brewing technique (aerobic or anaerobic) helps in extracting the nutrients from the compost and grows populations of beneficial microorganisms. Depending on the compost tea brewing techniques the compost teas are classified as Aerated Compost Tea (ACT) & Non Aerated Compost Tea (NCT) [10].

III. FACTORS AFFECTING COMPOST TEA

In compost tea quality production process some parameters, such as ratio of compost to water, oxygenation levels, duration and temperature of fermentation affect compost tea production. The brewing or fermentation process refers to the process of steeping compost in water at a constant temperature and for a specific period of time. Microorganisms convert insoluble nutrients in to available nutrients during the brewing process. The inconsistency has been associate with a number of factors that affect the production process. These factors include:

3.1 Compost Grade

The organic ingredients or feed stocks include animal manure landscape and agricultural plant material, bio solids and food waste the make up the mature compost. Each has characteristics that influence the quality of the mature compost. Vermicompost is used as an ingredient in many compost tea recipes. This compost is the highest in available nutrients. Important point to be noted is that mature compost should be stable and free of pathogens. Also the use of immature compost should be avoided as immature compost is less stable and may harbor pathogens [11].

3.2 Compost to Water Ratio

Optimum ratio of compost to water tends to vary, depending upon the brewing process, compost quality and purpose of compost tea application. Too little compost will result in dilute tea with low amounts of nutrients or organisms; whereas, too much compost may not allow maximum amounts of nutrients and microbial biomass of compost to be extracted [12]. Ratio of compost to water tends to vary for each production method. For NCT, the majority of studies use a 1:3 – 1:10 ratios. For ACT, ratio depends on type of equipment. Tap water is usually loaded with chlorine, which will kill some of microbes, so we need to dechlorinate the water. This is quite simple. Just add the water to the buckets, and use the aerator to bubble water through it for a minimum of 20 minutes. This will cause the chlorine to be released as a gas.

3.3 Brewing Time

Brewing (extraction) period is an important factor contributing to compost tea quality and efficacy. Compost tea should be brewed to an extent when most of the soluble nutrients and organisms from the compost are extracted or pulled out into the solution. Too short brewing period may prevent maximum extraction of nutrients and microbial biomass from the compost whereas too long brewing period may favor microbial immobilization of extracted nutrients leading to microbes become inactive once all the available foods are immobilized. For NCT, brewing time of 8-16 days is optimal fermentation time for any level of disease control. Similarly, Scheurell and Mahaffee (2002) noted that effectiveness of compost tea increases with increasing brewing time to a maximum and then decline [12]. Longer brewing period promotes greater amount of nutrients to be extracted from the compost and enables accumulation of antibiotics that activate natural plant defense responses and help in disease suppression. Ingham (2005) suggests that the optimum brewing time for ACT coincides with maximum active microbial population in the tea, often 12-24 hours with commercial aerobic compost tea makers [12].

3.4 Nutrient Supplement

Nutrients such as kelp, fish hydrolysate, molasses humic acid can be added as catalysts or microbial starter during brewing process to promote selective enrichment of microorganism. For both ACT and NCT, fermentation nutrients have the ability to inhibit or increase growth rates for different types of organisms. It is to be noted that the nutrients should be added with extreme caution [11].

3.5 Microbial Supplement

Compost contains a diverse group of organisms dominated by bacteria and fungi participating in decomposition of organic matter. Bacteria can grow and multiply in either oxygen rich aerobic and low or no oxygen anaerobic environments. Subsets of these species known as facultative anaerobes can grow in either the presence or absence of oxygen. Presence of facultative anaerobes in mature compost is likely associated with disease suppressive traits. Various fungal root rot disease have been suppressed by incorporating compost in to soil or soil-less growing media. For ACT aerobic bacteria predominate, while for NCT the population of bacteria is mainly facultative anaerobes [11].

3.6 Aeration

Aeration or oxygenation during ACT brewing process encourages growth and propagation of diverse group of good microbes extracted from the compost, while limited or lack of oxygen during NCT brewing process may support growth of human and plant pathogens. Brewing conditions in non aerated compost tea that favors a brief period of low oxygen may increase diversity of active microorganisms and disease suppressive properties of NCT, while sterilization of NCT eliminates the microbial population and disease suppression in the laboratory studies. NCT and ACT brewing techniques were compared with or without aeration and in presence or absence of nutrient additive for suppression of fungus phythium damping off of cucumber seeding. There is no significant correlation between the microbial population in the compost tea brewed under continuo aeration and disease suppression. Aeration during compost tea production process produces fewer foul odors than the non-aerated production process. For NCT, foul orders have been reported only under conditions where nutrient additives were added during the fermentation process [11].

IV. METHODS TO MAKE COMPOST TEA

Two dominant approaches being advocated in compost tea production are aerated and non-aerated methods. Irrespective of aeration, both methods intentionally ferment well-characterized compost in water for a defined period of time. Throughout this review fermentation is used in the common way, meaning the cultivation of microorganisms. Both methods of compost tea production require a fermentation vessel, compost, water, incubation, and filtration. There is debate over the necessity to aerate during compost tea production. The aerated production methods are associated with reduced production time.

Non-aerated production is associated with low cost, low energy input and many documented reports of plant disease control. NCT production has been suggested to cause phytotoxicity and provide an optimal environment for human pathogen re-growth. Aerated compost tea production requires mechanics and energy for continuous air addition; a number of designs are currently in use. Common aeration designs include showering recirculated water through a porous bag of compost that is suspended over an open tank, re-circulating water through a vortex nozzle mounted above a tank, injecting air through a hollow propeller shaft, venturi nozzles, aquarium stones, or fine bubble diffusion mats. NCT has traditionally been made by mixing one volume compost with 4 to 10 volumes of water in an open container, initially stirring the mixture, and then leaving it undisturbed at 15-25°C for at least 8-14 days. Brinton (et al, 1996) advocates stirring NCT every 2-3 days during the fermentation to possibly facilitate the release of microbes from compost particles. Container sizes range from several thousand liters down to small buckets. However, to avoid compost sampling error, at least 500g compost should be used when considering experimental designs for in vitro inhibition screening with NCT.

There are number of variations in compost tea producing equipments. These range from home-designed pieces to commercially available equipment, and every year efforts are made to improve the efficiency and decrease overall cost, which result in different designs. Given below are common compost tea production techniques:

4.1 Bucket-Fermentation Technique

For the bucket technique, compost and other non-soluble ingredients are either suspended in a bag (or a sack) or submerged to soak free in water. Note that when compost is free in the water, the non-soluble chunks need to be strained out of the tea for application. The bucket is half filled with water and stirred vigorously for approximately 10 to 20 minutes to de gas any chlorine. Compost is then added until the container is full, leaving about 3 cm or so from the rim for stirring. The mixture is brewed for several weeks, stirring periodically with a stick to mix it and add a small amount of air. After brewing, the solution is strained and applied to the crop. This technique of compost tea extraction has limitations. For example, the tea is likely to develop anaerobic conditions or toxic materials may be extracted into the tea as a result of anaerobic conditions [10].

4.2 Bucket-Bubbler Technique

The Bucket-Bubbler technique allows small quantities of compost tea to be made inexpensively, and is commonly used by homeowners and backyard gardeners. This is a modern version of the bucket technique. For this method, a 10 to 20 L bucket is fitted with air bubblers that are attached to an aquarium type aeration pump. The bucket is half filled with water and air is passed through it for approximately 10-20 minutes from the air bubblers to dechlorinate the water. Compost is then suspended in a bag & that bag is then submerged in the water. The aerator provides a continuous flow of air and creates enough turbulence to mix the brew. The minimum time for brewing is 2-3 days, but it can be brewed for longer if desired [10].

4.3 Trough Technique

For the trough technique, compost is suspended on a wire tray over a large tank of water. Water is pumped from the tank, sprayed over the compost, and allowed to drip through the compost back into the tank. The trough can range in size from 20-2000 litres. The brewing period lasts for several weeks. The water sprayed onto the compost does not provide enough force to physically remove the organisms from the compost. The spraying process aims to enable UV light to kill many of the organisms in the water droplets (where the unit is located outside) and allows the diffusion of oxygen into the droplets before impacting onto the compost. However, this commonly does not maintain enough oxygen to keep up aerobic conditions in the tea if molasses, sugars, humic acids, or some other food resource for the bacteria or fungi is added. Aerators are therefore often used to increase agitation of the liquid and to maintain aerobic conditions. Evaporation can be a serious problem for this technique, creating a concentration of salts in the tea. With the trough technique, some bacteria adhere to surfaces and develop bio-films (by producing extracellular polysaccharide or in some cases by means of specialised structures producing micro colonies), which may inhibit the maintaining of aerobic conditions. Bio-films typically establish on the surface of the brewing tea, especially in the corners of the tank. Bio-films can result in a significant amount of odour for a portion of the brew cycle. Round-bottom containers are preferable for brewing with this technique. The diversity of bacteria and fungi is typically quite limited in teas produced using this technique. If the tea has been brewed for a longer period of time using this technique, it is likely to be predominantly aerobic when ready for application [10].

4.4 Commercially available compost tea brewers

Though designs vary, most commercial aerated tea systems consist of a sack or a compost basket with drainage holes, either of which are used to hold a certain volume of compost. The compost filled container is placed in or above a specially designed tank filled with chlorine-free water. Microbial food sources are added to the solution to enhance microbial growth and diversity. A pump supplies oxygen to a specially designed aeration device, which bubbles and aerates the compost tea brewing in the tank [10].

V. Applications Of Compost Tea

Compost tea can be applied either to the soil or to the plant foliage. Compost tea is commonly applied to the soil by drenching the soil, directing compost tea into the root zone and affects the rhizosphere of the plant. Nutrients supplied with the tea are used by the plants as well as by the microorganisms. The microbes in the compost tea compete with other soil microorganisms, and in turn, become part of the soil and rhizosphere microbial ecology. Compost tea for soil applications does not necessarily require fine filtration before application thereby retaining microbial organisms in compost teas therefore provides greater total population and diversity of microorganisms than spray applications.

When applied to plant foliage, compost tea may alter the composition of organisms on the leaf surface, both through inoculation of organisms from the tea and through supply of foods that help support survival and growth of leaf-surface organisms. Compost tea applied to plant foliage has immediate impacts upon the plants welfare. Good quality compost tea that provides beneficial organisms and plant nutrients are essential, and should also avoid salt burn problems and risk of pathogens. The key is to achieve thorough coverage on both sides of the leaves. The addition of surfactants, sticking agents and UV inhibitors (referred to as spray adjuvants) to compost tea can increase the proportion of leaf area covered by beneficial microorganisms, thereby increasing leaf coverage and prolonging microbial survival by protecting against desiccation and harmful UV light. Compost tea for foliar applications can be applied with a broad range of sprayers. Tea should be preferably applied as a fine mist, so the liquid will remain on the leaf and not drip off.

Compost tea can also be applied via irrigation systems. As discussed, compost tea is usually filtered before spraying for foliar applications or applying via irrigation systems to prevent the clogging of sprayer nozzles and irrigation systems. Filtration removes a sufficient amount of particulate matter and some types of microorganisms tend to live attached to this particulate matter. As a result, these organisms may be poorly represented in filtered compost tea because of the necessity to strain out particulate material [10].

VI. BENEFITS OF COMPOST TEA

6.1 Compost tea as disease suppressor

The nature, diversity and concentration of microorganisms present in compost tea may influence its ability to suppress pathogens or inoculate the receiving plant with beneficial microbes. The concentration and diversity of microorganisms in compost tea differ and in most instances are lower relative to the compost source. Compost tea-related changes in soil and tissue microbial biodiversity have been reported to increase the range of biocontrol agents and increase the production of defensive substances by the plant. Compost tea may also impart a physical, morphological defense in plant roots through altered dispersal of border cells, which have a high affinity to trap bacteria [9]

Biological interactions that result in disease suppression of plant and soil borne pathogens are complex because disease caused by pathogens occurs in a dynamic environment .These interactions occur through the following mechanisms, which are not mutually exclusive.

1. Antibiosis: some beneficial organism can produce antibiotics or other substances that are toxic to the pathogenic organism's bacteria pseudomonas florescent strain CHAO produces hydrogen cyanide 2, 4 - diacetylphloroglucinol and pyoluteorin, which directly interfere with growth of various pathogens
2. Competition: when beneficial microorganisms are present in a growth medium they tend to outcompete pathogenic or fungi for food source
3. Induced resistance: some beneficial microbes colonizing on plant roots or foliage are documented to confer resistance to plant by turning on genes that increase plant tolerance to infection by pathogens
4. Parasitism: certain beneficial microbes can feed on specific pathogens. Tri-choderma species are shown in various studies to some enzymes that digest the cell wall of some fungal root pathogens.[11]

6.2 Compost tea as nutrient sources

Similar to compost, compost tea is a microbiologically active, nutrient-rich extract, which when used to irrigate crops (foliar or soil drench) influences growth, yield, nutrition and quality directly or indirectly through chemical and biological mechanisms. Direct modalities involve increased nutrient supply and action of microbial bioactive compounds including humic acids and phytohormones. Indirect mechanisms operate principally on the effect of microorganisms within the compost tea on pest suppression and enhancement of microbial communities that affect direct mechanisms of nutrient uptake or production of bioactive compounds.

Analysis of compost tea has revealed varying concentrations of plant mineral elements based on compost source, brewing methods and dilution. Increasing amounts of available nutrients in compost tea and their relationship with crop growth have also been confirmed by in previous research works. It has been postulated that the increased presence of soluble mineral nutrients can enhance nutrient uptake from soil and increase foliar uptake of nutrients. It was also inferred that compost tea increased the time stomata stay open, reducing loss from the leaf surface. Compost tea also increased permeability of cellular membranes in plants to minerals which increased plant growth. Increased nutrient uptake through compost tea has been reported to increase leaf area, which relatedly improves light interception, photosynthesis, water and nutrient use and dry matter production. [9]

From the above reviews we can conclude that, following are the benefits of compost tea:

1. Developing disease suppression or resistance towards disease to promote crop health and to reduce the need for pesticides.
2. Provision of water soluble available, nutrients for plants to decrease fertilizer requirements and associated costs.
3. Increased soil microorganism population and diversity to improve soil structure, water retention, rooting depth and plant growth.
4. Populating leaf surface thereby restricting growth of pathogens.
5. Competing for nutrients required by pathogens.
6. Secreting secondary metabolites on plant surface.
7. Directly parasitizing pathogens stimulating plant natural defence system.
8. Reduced use of pesticides
9. To improve soil structure and water percolation that helps to improve plant growth (particularly on compacted soils such as bowling green's which are compacted by continuous machinery use)
10. Nutrient and carbon cycling, providing nutrients for plant uptake
11. Improved foliar biology that helps to improve plant vigour
12. Improved yield. [10]

VII. COMPOST BIN

Municipal Solid Waste (MSW) Management is a significant global and local challenge. Improper MSW management involving open dumping or landfilling of mixed MSW which leads to greenhouse gas (GHG) emissions, increased levels of air pollution, spread of communicable diseases, contamination of water bodies etc. The compost bin system requires a closed container, which is also known as a reactor to perform the composting process in small volume. This system can be placed inside or outside the building, as long as the substrates are protected from environmental effects and the process is under controlled conditions [5].

Compost bin system can process large amounts of waste without taking up as much space as the windrow method and it can accommodate virtually any type of organic waste. This method involves feeding organic materials into a drum or bin. This allows good control of the environmental conditions such as temperature, moisture, and airflow. The material is mechanically turned or mixed to make sure the material is aerated. The dimension of the vessel can vary in size and capacity. This method produces compost in just a few weeks thus taking comparatively lesser time than conventional composting methods.

Some of the advantages of compost bin are - compost can be prepared in bin placing them either inside or outside of the house, as good air circulation is managed in bin there is no problem of odor, as the shape of the bin is good it does not give bad show even if placed in trans pass way, compost can be available every time in the house because it has been prepared in house from own home waste materials, there will not be any problem of insects and flies because wastes are used for composting which are well decomposed & pollution will be reduced with the good management of waste [13].

VIII. ADDITIVES

Various substrates that might be added to waste during the composting process to speed up the composting process are known as additives. Some added substrates are considered as bulking agents, when they only act on the physical structure of the compost (aeration), but most of the time, these substrates have also direct or indirect effects on other composting parameters and can be considered as additives. In other words, bulking agent is a carbon-based material that adds structure (or bulk) to your compost pile. Classic examples include: wood chips, wood shavings, saw dust, dry leaves, shredded landscape waste, shredded paper, shredded cardboard and animal bedding. Additives are used to enhance the composting process by reducing leaching and gas emissions, improving compost aeration or accelerating organic matter degradation and improving nutrient content and availability in the final product. A wide variety of additives, are classified in three categories: biological, organic & mineral which may be used to enhance composting process.

8.1 Biological additives

Biological additives refer to microorganisms, which are inoculated to a compost or vermicompost pile. These microorganisms are generally isolated from composts during the thermophilic phase, cultivated and sold as a commercial solution. Effective microbes and vertical transmitter bacteria are common commercial additives. However, in most of the commercial microbiological additives, Alcaligenes, Bacillus, Clostridium, Enterococcus and Lactobacillus microorganisms are present. These microorganisms are involved in the ammonia assimilation during composting or in the decomposition of lignocellulose. [8]

8.2 Organic additives

Organic additives cover a large variety of products: residual straws, mature composts refuse from green waste compost screening, grass clippings, crushed hardwood materials, crushed wood pallets, bark and cornstalk. When choosing organic additives, attention must be paid to the C: N ratio of the initial mixtures to ensure organic matter degradation and prevent N leaching during composting. Furthermore, biochar, a highly aromatic pyrolysis product, has recently received great interest as highly stabilised organic additive for composting and vermicomposting. As the production of biochar was shown to yield highly aromatic materials with high stability when added to soil, biochar may enhance the carbon sequestration potential of composts and vermicomposts, thus mitigating climate change. A great variety of biochar is produced, with different properties depending on the initial feedstock and pyrolysis temperature. [8]

8.3 Mineral or Inorganic additives

The main inorganic or mineral additives are lime, clays or industrial wastes, for example red mud or fly ash. Red mud is a by-product of the industrial alumina production, and fly ash is a waste product of clean coal combustion used to mitigate gas emissions (e.g. used in power plants). Therefore, the main advantages of these alkaline materials are their high availability and their low cost as industrial wastes. Minerals such as zeolite or Ca-bentonite became popular in the last decades due to their physical and chemical properties to adsorb heavy metals, in particular in soils and water purification system. Pure zeolite is easily synthesized by the slow crystallization of a silica-alumina matrix. Finally, pure minerals such as clay, extracted from quarries or soils, are increasingly used with the aim of reducing greenhouse gas emissions during composting. These minerals are sometimes added during vermicomposting & they have shown to stimulate the microbial activity, leading to an earlier start and a longer duration of the thermophilic phase as compared to regular composting. The duration of the thermophilic phase increased from 2 to 3 weeks following the addition of commercial products containing zeolite, kaolinite, chalk, ashes and sulphates or biochar addition during biowaste and food waste composting, thereby shortening the composting process. [8]

IX. VARIOUS ADDITIVES

9.1 Onion peel waste

Onion peels are the most common waste disposed in almost every kitchen. Among the three important constituents of plant cell wall material, the cellulose, lignin and hemicellulose, lignin is particularly difficult to biodegrade and reduces the bioavailability of the other cell wall constituents. The domination of different indigenous microorganism population at various stages of composting plays a distinct role in degrading lignin. They are easily available bulking agents, can act as moisture adjuster due to their low moisture content and have high cellulose content, which can be a good source of carbon. Also onion skin and peels have antioxidant properties and contain many useful substances like Sulphur, Potassium, phosphorus, zinc, iron, vitamins [5].

9.2 Waste tea powder

The used tea powder is generally just wasted, & is not utilized for any purpose and discarded as wet garbage. Tea powder can be a great source of biodegradable garbage but it can make a good source of compost as well.The used tea powder has increased concentration of essential nutrients needed for plant growth and development. It contains vitamin A, Carbon, Potassium, Phosphorus. It is also a good source of Nitrogen. The used tea powder is the suitable substrate for making compost. On basis of previous studies we can say that the composition of various nutrients showed increment in their (onion peels) concentration. The pot assay results also showed the improvement in plant growth [14].

9.3 Sawdust

By using bulking agent such as sawdust significantly reduced N_2O emissions during kitchen waste composting. Sawdust from all types of trees either may be they soft or hard can be used in compost pile. For composting purposes, sawdust is considered a “brown” composting material. It is therefore used to add carbon to the mix as well as to balance the nitrogen from the “green” composting materials, like greens and food wastes. Sawdust makes a perfect amendment for compost pile, as it adds filler that is somewhat absorptive and will pick up water from rain and juices from the green material, helping along in the composting process. Plants need nitrogen in large amounts for proper growth, the lack of which results in chlorosis or yellow leaves, stunted

growth, and other problems in plants. On the other hand, composted sawdust contains the nitrogen, potassium and phosphorous required by plants for healthy growth and development. [8]

9.4 Banana peels

Banana peels have useful substances like Potassium, Phosphorus. It also has antioxidants, some metals like manganese &magnesium. Banana peels form about 18-33% of the whole fruit mass and are considered as a waste product. At present, these peels are not being used for any other purposes and are mostly dumped as solid waste at large expense. Banana peels possess many benefits as they are an important source of soluble and insoluble fiber, antioxidants. [17]

Moreover, the peel of a banana contains some minerals & metals including potassium, phosphorus, calcium, and manganese, magnesium and others respectively. Potassium is the most important element that is used as fertilizer. It is essential for promoting general plant vigor, build up, and resistance to pest and disease; necessary to help fruit grow; involved in regulating around 50 enzymes in a plant. Potassium content in banana peels is about 200 mg of the fruits or 40%. Using banana peels in the garden provides nutrients that plants need to thrive, and it acts also as a pest repellent. Aphids do not like banana peels, so in that case also we can use the peels around roses and cauliflower to deter the crawling pests. [16]

9.5 Jaggery

Glucose and Jaggery serves as food for rapidly growing microorganisms. Adding jaggery increased the number of microorganisms and thus enhanced the enzymatic degradation of cellulose during composting of green wastes. Rapid temperature increases were observed following the addition of polymer additives (zeolite, jaggery and polyethylene glycol) during composting of animal manure, food waste and green waste. [8]

9.6 Biochars

The effect of biochars on microbial activity was probably due to their effect on microbial habitat and protection from grazers. Biochar, due to its porous structure, might also enhance microbial activity through moisture and aeration control, which also has an effect on compost temperature. The temperature increased rapidly on addition of biochar. However, a biochar application rate higher than 20% is not recommended since it may hinder organic matter biodegradation.

As the production of biochar was shown to yield highly aromatic materials with high stability when added to soil, biochar may enhance the carbon sequestration potential of composts and vermicomposts, thus mitigating climate change. A great variety of biochars is produced, with different properties depending on the initial feedstock and pyrolysis temperature. Generally higher temperatures lead to greater aromatisation of the material, decreasing its surface area, cation exchange capacity and content of volatile compounds.

The duration of the thermophilic phase increased from 2 to 3 weeks following the addition of commercial products containing biochar addition during biowaste and food waste composting, thereby shortening the composting process. Compost stability was already achieved after 50–60 days when amended with biochar [8].

9.7 Fly ash

Fly ash which is being dumped in ash ponds by thermal power stations occupies around 1, 00,000 ha of land in India & disposal of such tremendous amount of fly ash has become an environmental threat since it has been an utterly under-utilized resource for a long time. There are numerous reasons behind the under-utilization of fly ash, such as lack of awareness, stringent policies regarding fly ash management, and the most critical factor is the readily available land. Fly ash is enriched with both macro & microelements and also contains heavy metals, such as Cadmium (Cd), Lead (Pb), Nickel (Ni), Chromium (Cr), Zinc (Zn), Molybdenum (Mo), Arsenic (As) and Copper (Cu). Depending on the sulphur contents present in the parental coal, the pH ranges from 4.5 to 12.0. Fly ash contains all the elements similar to those present in soil except Nitrogen & a negligible amount of organic carbon. Thus, except Nitrogen all other essential elements required for the metabolism and growth of microbes and plants are readily available in fly ash. [15]

CONCLUSION

The landfilling technique of waste disposal will not be feasible in upcoming years, thus there is an urgent need to find an alternative technique for disposal of MSW. Also if the organic matter in waste is just dumped into the landfills it causes various environmental issues. Thus we can use the bin composting technique to treat this organic matter from the waste in rapid manner. To accelerate the process of composting furthermore, we can also use various additives & bulking agents which facilitate the process of composting. Adding mineral, organic or biological materials during composting and vermicomposting affects composting parameters and may be used to: influence the key parameters of the composting process, such as aeration and porosity of the pile, and composting duration by manipulating the thermophilic period; enhance the agronomic value of the final products by increasing nutrient contents and reducing metal mobility or increasing carbon stability and limit odour and GHG emissions

Also there are several organic fertilizers and nutrient sources available but very few with liquid options. Compost tea presents the best alternative liquid organic nutrient source for horticultural and agricultural use. Its origin in compost ensures that the product is sanitary and contains soluble constituents of the compost. By definition, being associated with mature compost also minimizes the potential for phytotoxic compounds and effects on crop health and soil quality. Regardless of the nature of the composting system, composting feedstock and brewing conditions, compost tea has been reported to enhance soil quality through increased microbial diversity and nutrient availability and increase crop growth and importantly yield. The latter is especially so when compost tea is combined with mineral or organic fertilizers. Several mechanisms have been posited for the altered effects associated with compost tea use including increased availability and uptake of nutrients especially when applied as a foliar treatment. Secondary mechanisms include increased soil organic matter and nutrients turnover through microbial activity. Further benefit is derived through the suppression of plant pathogens which provides the best opportunity for maximum growth.

Thus this review highlights the fact that compost tea has shown potential for being more useful than traditional compost as it contains nutrients in readily available form, thus making it easier for plants to uptake & utilize those nutrients. Also compost tea

can be easily used in existing irrigation or spray equipment, or as a soil drench. Such & many more other benefits of compost tea make's it better than traditional compost.

Acknowledgment

Any accomplishment requires work and efforts of many people. Thus I would like to acknowledge Principal of Government College of Engineering, Amravati, Head of Civil Engineering Department and my Guide Dr. M. N. Hedaoo, for their support.

REFERENCES

[1] Siti Noratifah Jamaludin , Aeslina Abdul Kadir and Nur Wahidah Azhari 2017. Study on NPK Performance in Food Waste Composting by Using Agricultural Fermentation. ISCEE 2016, 103, 05015.

[2] V. Sudharsan Varma , Ajay S. Kalamdhad 2014 March. Effects of Leachate during Vegetable Waste Composting using Rotary Drum Composter. Environmental Engineering Research, 19(1) : 67-73.

[3] Chaney C.G. St. Martin, M.K. Meghvansi, A. Varma 2015. Organic Amendments and Soil Suppressiveness in Plant Disease Management. Springer International Publishing Switzerland, Soil Biology 46, 10.1007/978-3-319-23075-72.

[4] Manual on, Use of Compost Tea as a Nutrient Amendment for Plant Growth in a Re-Circulating Hydroponic System, May 2010.

[5] Norazlin Abdullah, Nyuk Ling Chin, Mohd Noriznan Mokhtar and Farah Saleena Taip 2013. Effects of bulking agents, load size or starter cultures in kitchen-waste composting. Springer open journal, International Journal Of Recycling of Organic Waste in Agriculture 2013, 2:3.

[6] Hatam Shaban, Bahman Fazeli-Nasab2, Hasan Alahyari, Gholam Alizadeh, Sadegh Shahpesandi January 2015. An Overview of the Benefits of Compost tea on Plant and Soil Structure. Adv. Biores. Vol 6 [1]: 154-158. DOI: 10.15515/abr.0976-4585.6.1.154158.

[7] Vivek Manyapu, Sudeep Shukla, Sunil Kumar, Kushagra Rajendra 2017. In-vessel composting: a rapid technology for conversion of biowaste into compost. Open Access Journal of Science & Engineering, Volume 2, Issue 9.

[8] Justine Barthod, Cornelia Rumpel & Marie-France Dignac 7 March 2018. Composting with additives to improve organic amendments. A review. Springer-Verlag France SAS, part of Springer Nature 2018, Agronomy for Sustainable Development 38: 17.

[9] Open Access books by Gaius Eudoxie and Micah Martin. Compost Tea Quality and Fertility 2019

[10] Manual by Recycled Organics Unit and NSW Department of Environment and Conservation. Overview of Compost Tea Use in New South Wales 2006.

[11] Hatam Shaban, Bahman Fazeli-Nasab, Hasan Alahyari, Gholam Alizadeh, Sadegh Shahpesandi January 2015. An Overview of the Benefits of Compost tea on Plant and Soil Structure. Adv. Biores. Vol 6 [1]: 154-158. DOI: 10.15515/abr.0976-4585.6.1.154158.

[12] Theodore Radovich & Norman Arancon 2011. A handbook for compost tea production and use.

[13] User Manual for Home Compost Bin- How to Use Home Compost Bin. The Study on the Solid Waste Management for the Kathmandu Valley.

[14] Minakshi Gurav, Smita Sinalkar 2013. Preparation of organic compost using waste tea powder.National Conference on Biodiversity : Status and Challenges in Conservation - 'FAVEO' , 978-81-923628-1-6.

[15] Ashootosh Mandpe, Sonam Paliya, Sunil Kumar, Rakesh Kumar 20 August 2019. Fly ash as an additive for enhancing microbial and enzymatic activities in invessel composting of organic wastes. Elsevier, Bioresource Technology 293-122047.

[16] Hariyono, Mulyono, Q Ayunin 2020. Effectiveness of Banana Peel-Based Liquid Organic Fertilizer Application as Potassium Source for Eggplant (Solanum melongena L.) Growth and Yield. IOP Conf. Series: Earth and Environmental Science 752 (2021) 012022.

[17] H S Hussein, H H Shaarawy, Nabila H Hussien and S I Hawash 2019. Preparation of nano-fertilizer blend from banana peels. Springer 43:26.

[18] Gabhane, Jagdish & William, SPM & Bidyadhar, Rajnikant & Bhilawe, Priya & Anand, Duraisamy & Vaidya, Atul & Wate, Satish 2012. Additives aided composting of green waste: Effects on organic matter degradation, compost maturity, and quality of the finished compost. Elsevier, Bioresource technology. 114. 382-8. 10.1016/j.biortech.2012.02.040.

[19] M.E. El-Haddad, Mona S. Zayed ,G.A.M. El-Sayed , M.K. Hassanein , A.M. Abd El-Satar 3 September 2014. Evaluation of compost, vermicompost and their teas produced from rice straw as affected by addition of different supplements. Elsevier, 59(2) 243-251.

[20] Sutripta Sarkara, Subrata Pala, Sunanda Chandab 2016.Optimization of a Vegetable Waste Composting Process with a Significant Thermophilic Phase. Elsevier, Procedia Environmental Sciences 35 (2016) 435 – 440