*Eco. Env. & Cons. 30 (July Suppl. Issue) : 2024; pp. (S503-S512)*
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*ISSN 0971–765X*

**DOI No.: http://doi.org/10.53550/EEC.2024.v30i04s.082**

# A Review on Organic Composting Technology by using Different Microorganisms

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(Received 27 December, 2023; Accepted 14 February, 2024)

**ABSTRACT**

Composting is a technological waste management method in which organic material is broken down and stabilized into a biodegradable mixture in the presence of aerobic microbial activities, ultimately becoming compost. The breakdown of organic matter has garnered significant interest recently owing to its eco-friendly approaches that prevent further pollution of the environment. The process of breaking down of organic matter into carbon dioxide, heat, water, humus, and compost, a rather stable end organic product is facilitated by microorganisms such bacteria, fungus, and actinomycetes. Microorganisms break down the intricate lignin, cellulose, and hemicellulose molecules during the composting process. The content of composite mixtures and temperature fluctuations throughout the composting process have an impact on the existence of various microorganisms. The temperature rises at the start of compression due to a large increase in microbial activity. The fungi that are most active during the compost maturation process take over from the initial dominance of bacteria. The most significant variables affecting the success of decomposition are the C/N ratio, temperature, humidity, particle size of the substrate, pH, oxygen content, and microorganisms. The final stable product, known as compost, is a sustainable fertilizer and soil improver that contains humified fraction similar to humus. It may be used to increase the efficacy of fertilizers, improve the physico-chemical features of the soil, and encourage crop growth. Humic materials enhance soils with minerals that are essential to plant growth, including calcium, phosphorus, potassium, and nitrogen. Additionally, composting, which recycles byproducts and is based on the circular economy model, is a clever and sustainable way to lessen the harmful environmental effects associated with waste management.

***Key words:*** *Composting, Phases of Composting, Microorganisms and Factors Effecting Composting*

## Introduction

Composting is a recommended and ecologically responsible technique that uses biological processes to convert organic waste into fertilizer and soil conditioners (Gautam *et al*., 2010). Compost works well for revegetation and erosion management because of its high organic carbon content and biological activity (Anastasi *et al*., 2005). Three stages make up the composting process, which uses a variety of microflora to eventually turn organic waste into humus. These microflorae include bacteria, fungi, and

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mesophilic and thermophilic (Zeng *et al*., 2011). Both the temperature and carbon dioxide levels rise during the first phase. The breakdown of sugar and proteins by mesophilic organisms results in a reduction of the substrate (Novinsak *et al*., 2008). The temperature in the compost piles rises from 45 °C to 70 °C during the second phase, and mesophiles replace the thermophiles (Pedro *et al*., 2003). At the beginning of the third phase, the temperature is lowered by the compost piles (Chinakwe *et al*., 2019). Compost's raw materials determine every characteristic of its stability and quality. The C:N ratio, composting temperature, pH of the final product, moisture content, and the existence of possible pathogens like coliform bacteria are some of the factors that are used to evaluate the quality and stability of the compost during the process (Fourti *et al.,* 2011 and Sanmanee *et al.,* 2011). The physical attributes of compost encompass a range of factors, such as particle size distribution, bulk density, number of inert elements, stability and maturity. Measurements of stability are used to assess if the compost has sufficiently cured to prevent excessive leaching or inhibition of plant growth. Although there is considerable disagreement regarding the most effective test or set of tests and indicators to use for measuring stability, the Dewar self-heating test and the Solvita test for carbon dioxide respiration are commonly used. Relative stability has also been shown by the CEC. How much glass or other debris has been added to the compost can be determined by looking at the number of inert materials.

The C/N ratio, humidity, oxygen, pH, temperature, and make-up of all the raw ingredients in the compost mixture are some of the variables that impact the composting process (Kumar *et al.,* 2010). The C/N ratio has a major impact on the composting process since a too broad ratio makes it take longer, and a carbon shortfall promotes nitrogen instability, which leads to substantial losses in ammonic form (Wichuk and McCartney, 2010). The chemical and microbiological activities involved in composting require humidity, and a 50–60% humidity level is appropriate throughout this process. Moisture content affects the physical construction of solid matrices and the physiological traits of bacteria during the composting of materials. Because of the increased microbial activity during composting, aerobic bacteria show more active oxygen consumption if the moisture content is kept at an appropriate level. Low moisture contents prevent the growth of beneficial microorganisms (Umsakul *et al*., 2010), while excessive moisture can produce anaerobic conditions that result in the creation of harmful volatile compounds and disagreeable odors (Umsakul *et al.,* 2010). Moisture therefore seems to be a major influencing element for microbial activity (Anastasi *et al*., 2005).

**Phases of composting**

Composting is a biological process that turns organic wastes into a homogenous, plant-available material in a sanitary manner under aerobic (oxygen-containing) conditions with suitable moisture and temperature. Many bacteria carried out intricate metabolic activities to create their own microbial biomass throughout the composting process in the presence of carbon, nitrogen (N), and oxygen (C).

In the process, the microbes also produce heat and a solid substrate known as compost, which has less carbon and nitrogen but is more stable (FAO, 1980 and 2020). Temperature fluctuations occur over the course of the decomposition process as a result of the observable heat produced by the metabolic activities of microorganisms during the early complex organic C, N, and organic matter's breakdown. Aside from a maturation period, the three primary stages of composting have been determined by the temperature fluctuations. Depending on the temperature (Nemet *et al*., 2021), these various composting stages have been divided into the following categories:

- The Mesophilic Phaseor Hot Phase
- Thermophilic and Hygienization Phase
- Cooling or Mesophilic Phase II
- Maturation Phase

**The Mesophilic Phaseor Hot Phase**

The first mesophilic phase (10–45 °C), when organic matter decomposition begins and the temperature rises quickly. After a few days, the temperature rises to 45 °C as the composting process begins at room temperature. Because these microbes need the N and C in the organic matter for body absorption, the metabolic activity of a heterogeneous group of microorganisms causes an increase in temperature (Awasthi *et al*., 2019). The pH can decrease (to approximately 4.0 or 4.5) as a result of the breakdown of soluble substances, such as sugars, which produces organic acids. Two to eight days pass during the heat period (Neklyudov *et al*., 2008).

**Thermophilic and Hygienization Phase**

The thermophilic phase (45–70 °C), which is characterized by consistently high temperatures because of the intensive metabolic processes that endogenous microbes carry out. The mesophilic microorganisms are replaced by thermophilic microorganisms (mostly thermophilic bacteria), which can thrive at higher temperatures, when the temperature of the parent organic material reaches more than 45 °C. These thermophilic microbes aid in the breakdown of complex organic materials like lignin and cellulose. During this stage, the compost pile's pH rises as a result of the thermophilic bacteria's conversion of nitrogen into ammonia. Particularly, above 60°C, the development of actinobacteria and bacteria that produce spores and are in charge of decomposing waxes, hemicellulose, and other C complex substances starts. During this phase, the high temperature of the compost pile aids in the destruction of faecal pollutants and bacteria, such as *Salmonella* sp. and *Escherichia coli*. Thus, this phase is also known as the hygienization phase. Examples of these include helminth cysts and eggs, phytopathogen fungus spores, and weed seeds. Simultaneously, this phase is highly favorable since the high temperature (over 55 ºC) aids in the removal of weed seed, helminth cysts, spores of phytopathogen fungus, and any other hazardous bacteria that may have been present in the parent material. It also helps to raise a hygienic product.

**Cooling or Mesophilic Phase II**

The middle mesophilic phase, when a drop in temperature permits the regrowth of heat-resistant microorganisms. In this phase, the temperature of the pile drops once more to between 40 and 45 ºC once the carbon and nitrogen sources in the composting material are exhausted. Mesophilic phase: cellulose continues to break down polymers, and certain fungi that are visible to the unaided eye start to grow. The activity of mesophilic organisms increases and the pH of the compost pile somewhat decreases as the temperature drops below 40 ºC; overall, the compost pile's pH stays somewhat alkaline. There are fungi that can grow and even form visible structures. This cooling phase can be mistaken for the maturation phase and takes several weeks.

**Maturation Phase**

The final stage, when biological heat production and organic matter stabilize. The temperature of the compost pile decreases to ambient levels (20–30 ºC) during the maturation period. This is also the time when carbonaceous molecules condense and polymerize, which aids in the creation of fulvic and humic acids (Chen *et al.,* 2011).

**Role of micro-organisms in composting**

According to Ling *et al.* (2014), the dynamics or succession of a microbial population during composting indicates their capacity to degrade the compost mix. Variations in a microbiome during the process are mostly determined by the raw material and nutritional supplement composition, the trial or ambient environmental conditions, and the interactions between all of these variables. Here, the most prevalent and quickly growing microorganisms during composting are fungi and bacteria. The microorganisms participating in the process and the substrates used have a significant impact on the final compost's quality (Villar *et al.,* 2016). By releasing a variety of substrate-based hydrolytic enzymes that break down complex molecules into water-soluble chemicals (Echeverria *et al.,* 2012), they aid in the decomposition of organic matter during composting (Lee, 2016). In addition to breaking down the organic matter, they also create easily utilised compounds that, when added to soil, improve agricultural potential and maintain the balance of the ecosystem. A clear picture of compost maturity events can be obtained through the mapping of several physiological microbial profiles during the composting process. According to Karak *et al.* (2014), an initial profiling revealed a predicted decline in the microbial biomass, which was linked to variations in the C/N ratio and temperature of the composting mass. According to Vargas-García *et al.* (2010), the bacterial population continued to grow during the mid-mesophilic stage of composting, producing more enzymes that led to appropriate humification. Eventually, during the cooling or maturation stage of waste composting, microbial mass gradually decreased. In general, the bacterial population was more abundant than the fungal population during the procedure (Chandna *et al.,* 2013). An effective microbiota can be developed by making specific changes to the process of integrating bulking substances (such as sawdust, wood chips, rice husk, and others) as additions to the substrate. This would preserve the compost's quality and further optimize the C/N ratio (Zhang *et al.,* 2013; Yuan *et al*., 2015; Anwar *et al*., 2015).

**Microbial additives**

Organic waste naturally composts through moist decomposition, however there is disagreement over how effective it is to inoculate this process. Microbes that are both dominant and non-dominant coexist in an EM culture, with the former being more active.

The study conducted by Rastogi *et al.* (2019) showed that the addition of efficient microorganisms (EM) to treatment mixtures through inoculation increased the rates of waste breakdown. Furthermore, these additives can be produced using culture mixtures comprising soil, cow dung, straw, and other materials, or they can be extracted from the microbial communities based on particular degradative functionalities (Liu *et al.,* 2011). A few recognized powerful cellulose-producing bacteria are Thermoactionmycetes, *Bacillus* species, Pseudomonas, and Cellulomonas. Similarly, extracellular enzymes produced by Aspergillus, Trichoderma, Sclerotium, and white-rot fungus are responsible for the breakdown of cellulose and lignin during the composting process (Awasthi *et al.,* 2015). By keeping an eye on the alterations in biological traits (microbial succession) that take place during the process, compost quality can be determined. The veracity of the compost can be ascertained by examining its pH, C:N ratio, color, humic substances (HS), electric conductivity (EC), pathogenic activity, germination index (GI), and total nitrogen, phosphorus, and potassium contents. Because mesophilic and thermophilic bacterial populations flourish when added to compost mixes, microbial additives have an impact on temperature profiles and ammonia emissions (Barthod *et al.,* 2018). Furthermore, the rapid composting by these efficient microorganisms was explained by reduced initial biological lag time and increased enzymatic activity (Saad *et al*., 2013). Additionally, it can produce compost with a better nutritional content and efficiently reduce odorous emissions, primarily volatile organic compounds (VOCs) (Jusoh *et al*., 2013; Maulini-Duran *et al.,* 2014). After proteins break down during composting, a few other notable sources of these emissions include ammonia, an odorous nitrogen molecule, and sulfur-based emissions (Zhang *et al*., 2013). Kitchen waste composting has been shown to have a beneficial impact on the emission of odorous substances, such as ammonia and volatile organic compounds (VOCs) Shao *et al*. (2014) and Yuan *et al.* (2015). Furthermore, according to Charles and Ho (2017), adding EM to the organics increased their rate of decomposition and decreased their odorous emissions.

**Bacteria**

A gram of compost normally contains 80–90% billions of microorganisms, of which bacteria are the most abundant and living form. They use a wide range of enzymes to chemically break down a variety of organic compounds, making them the most nutritionally diversified group of compost organisms. Bacteria are single-celled organisms that can take the form of spiral spirilla, sphere-shaped cocci, or rod-shaped bacilli. Numerous species possess the ability to move independently, a quality known as motility. Mesophilic bacteria rule at the beginning of the composting process (0–40 °C). The majority of them are types that are also present in topsoil. Thermophilic bacteria take over when the compost reaches temperatures above 40 °C. During this stage, Bacillus members predominate in the microbial populations. At 50–55 °C, there is a decent amount of diversity among bacilli species; but, at 60 °C and higher, there is a significant drop in diversity. Bacilli create endospores, thick-walled spores that are extremely resistant to heat, cold, dryness, and starvation, in order to thrive in unfavorable environments. They are found all over nature and come out to play when the weather is right. Thermus bacterium has been isolated at the highest compost temperatures. Occasionally, composters ponder how naturally occurring microbes acquired the ability to endure the elevated temperatures seen in active compost. It's possible that thermus bacteria developed in Yellowstone National Park's hot springs, where they were initially discovered. Additional natural locations with thermophilic conditions include manure piles, deep sea thermal vents, and collections of decaying vegetation that have the ideal temperature to heat up similarly to a compost pile. After the compost cools, mesophilic bacteria take center stage once more. The spores and organisms that are present in the compost as well as in the nearby environment determine the quantity and kinds of mesophilic microorganisms that recolonize it as it ages. The more varied the microbial community that is supported, generally speaking, the longer the maturation or curing phase.

**Actinomycetes**

Actinomycetes, which are filamentous bacteria that resemble fungi, are the source of the distinctive earthy smell associated with soil. They develop multicellular filaments like mushrooms; however, they do not have nuclei like other bacteria. In the process of composting, they are crucial in the breakdown of complex organic materials such proteins, cellulose, lignin, and chitin. Their enzymes allow them to chemically decompose difficult waste, such newspaper, bark, and woody stems. When the thermophilic phase ends and only the most resilient compounds are left in the final stages of humus formation, certain species emerge and become significant during the colder curing phase. Actinomycetes create lengthy filaments that branch off and resemble gray spider webs that crisscross compost. Towards the end of the composting process, in the outer 10 to 15 centimeters of the pile, these filaments are most frequently observed. Occasionally, they seem like spherical colonies that progressively get bigger.

**Fungi**

Numerous complex plant polymers found in soil and compost are broken down by fungi, which also include yeasts and molds. Fungi play a crucial role in compost because, once the majority of the cellulose has been used up, they help bacteria carry on the decomposition process by breaking down difficult waste. By creating a large number of cells and filaments, they proliferate and spread quickly. They can also target organic wastes that are too dry, acidic, or poor in nitrogen for bacteria to break down.Saprophytes, or living on dead or dying material, are categorized as the majority of fungi. They derive their energy from decomposing organic materials from dead plants and animals. Both the thermophilic and mesophilic stages of composting involve a large number of fungal species. on high temperatures, the majority of fungus reside on the outer layer of compost. Strict aerobes called compost molds develop as both invisible filaments and fuzzy, gray or white colonies on the surface of the compost.

**Protozoa**

Microscopic one-celled creatures are called protozoa. Although they are present in compost's water droplets, their involvement in the process of decomposition is quite small. Similar to bacteria, protozoa feed on organic debris, but they also eat bacteria and fungi as secondary consumers.

**Rotifers**

Rotifers are tiny, multicellular organisms that are also present in the compost's watery coatings. They consume fungus and bacteria in addition to organic stuff.The minute multicellular creatures called rotifers are present in compost and aid in the breakdown of organic wastes by ingesting bacteria and fungi (Ogello *et al*., 2020).

**Factors Influencing the Process of Composting**

Composting is a biological process, microbes are essential, so it is important to consider the variables that affect their growth and reproduction. Aeration or oxygen, temperature, pH, substrate moisture content, and the C:N ratio are some of these variables (Li *et al*., 2013). Microbes in composting needed C, N, P, and K as their main nutrients (degradable organic carbon) for growth and as a source of additional energy (Iqbal *et al*., 2015). The degradability of trash throughout the composting process might also differ based on the waste's chemical composition, the natural load, and the microbiological activity in the compost matrix (Bernal *et al*., 2009). During composting, the rate of organic matter decomposition and microbial activity were directly impacted by the ambient conditions (Hueso *et al*., 2012). External factors that affect the composting process include raw materials, method, and ambient conditions; therefore, certain parameters may change. These factors, however, need to be constantly monitored and kept within an ideal range.

**Carbon-Nitrogen (C: N) Ratio**

The production of an effective compost mix requires a nutritional balance in the form of an ideal C/N ratio. Changes in C/N over time predicted how quickly organic matter degraded, with the amount of carbon converted to $CO_2$ controlling this process. The ideal C/N ratio is between 25 and 35, meaning that microorganisms need 30 parts of C for every unit of N (Kutsanedzie *et al.,* 2015). When the C/N ratio exceeded the acceptable level, the composting process slowed down and the microbiota reported a nutritional shortage because of the excessive substrate accumulation. On the other hand, a lower C/N led to higher N content per C (degradable) and inorganic nitrogen, which is more likely to be lost as ammonia by leaching or volatilization (Zhang *et al*., 2016)

**Aeration (Oxygen)**

Composting is an aerobic process and adequate ventilation should be maintained to allow respiration of microorganisms that release carbon dioxide ($CO_2$) into the atmosphere. Similarly, aeration also helps in reducing compaction or water filling in the compost material. Oxygen requirements vary during the process, reaching the highest rate of consumption during the thermophilic phase. According to Latifah *et al.* (2015), the ideal range for oxygen concentration for composting is between 15 to 20%. Here, the microbial dynamics and temperature (kept below 60–65 °C) are directly associated with the oxygen concentration to guarantee enough oxygen supply for the process. The oxygen saturation level of the compost pile should not be <5% (optimum level 10%). Excessive aeration level results in temperature drop and moisture loss by the evaporation process and the low level of moisture hamper the decomposition process. Excess aeration also causes the dehydration of microorganisms' cells which further hampers production of the spores and enzymes which proliferate the degradation of various compounds of added organic matter. Contrarily, low aeration level (usually below 5%), results in excessive moisture which further generate excess moisture and anaerobic environment. Odours and acidity are then produced by the presence of compounds such as acetic acid, hydrogen sulphide ($H_2S$) or methane ($CH_4$) in excess (Nemet *et al*., 2021). Early composting stages with enough aeration lowered the time it took for the waste to stabilize, which led to the complete conversion of carbon (C) to carbon dioxide ($CO_2$) and a decrease in methane emissions. However, too much aeration of the matrix may lead to improper composting, which would have a significant impact on the rate at which garbage decomposes (Awasthi *et al.,* 2014).

**Carbon Dioxide ($CO_2$)**

In all aerobic activities, whether breathing by humans, animals, or plants, or composing, oxygen is essential for the conversion of carbon in the raw material's carbon to fuel. For plants and other autotrophic bacteria, photosynthesis is carried out by the oxidation process, which converts carbon into biomass and carbon dioxide produced during microbial respiration (Virginia, 1997). The kind of raw material utilized and the activity of hetrotrophic bacteria throughout the composting process cause $CO_2$ to be released through their respiration. Since $CO_2$ is needed by plants for photosynthesis, an average of 2-3 kg $CO_2$/tonne of composting material is produced, which has little impact on the environment.

**Moisture**

As the water in the raw material is required by the microbes to transmit nutrients and energy across their cell membranes, the microbial activity and moisture content in composting material are tightly correlated. According to Petric *et al.* (2015), the moisture conditions have a significant impact on temperature, microbial activity, oxygen uptake rate, and porosity level during composting. According to the size of the particles, the material's physical state, and the composting system, the moisture content of the composting material changes. Roughly 55% moisture content is the appropriate quantity for the compost material (Karnchanawong and Nissaikla, 2014). In contrast to pH, the relationship between temperature and moisture content is inverse, showing a rise in temperature as moisture content decreases (Varma and Kalamdhad, 2015). The rate at which organic matter decomposed decreased as a result of the increased evaporation brought on by the greater temperature. For the waste microbiota to function properly and to maintain appropriate moisture conditions, treatment piles must be rewetted. On the other hand, excessive moisture content during composting could result in water logs with a high anaerobic environment, which could stop the process (Makan *et al.,* 2013). With rice straw as an exception, lignocellulosic composting requires a higher moisture level in order to soften the dense fibrous material, which has a beneficial impact on the process (Kádár *et al*., 2012).

**Temperature**

Similar to aeration and moisture content, temperature also promotes the microbial community's growth and metabolic activity within the compost pile. It may have a direct impact on how quickly organic matter decomposes during composting (Waszkielis *et al.,* 2013). The process phase affects the vast range of variations in ambient temperature. Without human assistance, composting can commence at room temperature and reach up to 65 °C (external heating). The compost pile reaches room temperature during the maturation process. The temperature of the pile shouldn't decrease more quickly since the high temperature and longer time period have a high rate of hygienicization and decomposition. The ideal temperature range for trash decomposition and maximum sanitization during composting was 50–55 °C. Additionally, according to Pandey *et al.* (2016), temperatures and processing duration work together to completely eradicate the pathogens from the compost material. On the other hand, prolonged exposure to high temperatures (over 70 °C) might cause the microorganisms (fungi, actinomycetes, and bacteria) to become inactive throughout the composting process, which calls for the preservation of a specific temperature regime (Varma and Kalamdhad, 2015). By controlling the size and form of the composting mass through turning activities, the excess heat can be eliminated and temperature redistribution and cooling are enhanced (Chowdhury *et al.,* 2013).

### pH

Since most of the raw materials are already sorted within the advised pH range, pH is not thought to be crucial in the early stages of composting (Rich and Bharti, 2015). In some way, the volatilization (ammonia) and microbial nitrification processes that produce more $CO_2$ and acids during composting may be linked to a lower pH (Wang *et al.,* 2016). The pH of composting fluctuates throughout each stage of the process, ranging from 4.5 to 8.5, depending on the source materials. Early on in the composting process, the microorganisms' release of different organic acids caused the pH of the compost pile to acidify (Zhang and Sun, 2016).

As a result of ammonium being converted to ammonia during the thermophilic phase, the pH increases and the medium becomes alkalized, eventually stabilizing at values that are almost neutral. Microorganisms depend on pH to survive, and each type of microbe has a preferred pH range for development and reproduction. nitrogenous chemicals were present in the compost mass, indicating decreased microbial activity and a pH over 9.0. A high pH causes the compost mass to become alkaline, which can make it more difficult for microbes that are sensitive to pH to survive. This greatly contributes to the compost's cleanliness (Hachicha *et al*., 2009). Furthermore, as demonstrated by the co-existence of many microbial communities at varying pH and treatment configurations, temperature and pH can jointly impact the waste degradation process (Sundberg *et al*., 2013). Most fungal activity happens at pH 5.5 to 8.0, whereas most bacterial activity happens at pH 6.0-7.5. The 5.8 to 7.2 range is the optimal range acidify (Zhang and Sun, 2016).

### Particle size

The simple access to the substrate, or particle size, is correlated with microbial activity. Composting particles of very small sizes have a higher specific surface area, which makes the substrate easier to reach. For composting, parent materials should be between 5 and 20 cm in size. The aeration and moisture retention of the compost pile are ultimately influenced by the density of the composting material, which is directly correlated with particle size. The porosity level of the compost mass is ensured by the particle size, which also controls the gas/water exchange and provides appropriate aeration (Zhang and Sun, 2016). When estimating the process's operational expenses, the right particle size and shape are crucial (Wang and Ai, 2016).When composting begins, the density of the composting material is roughly 150–250 kg/m$^3$, but as the process advances, it can reach 600–700 kg/m$^3$. According to Ge *et al*. (2015), "sieving" is a basic technique for figuring out the ideal distribution of particle size in a compost mass. The debris can be chipped and shredded into smaller pieces to get the right particle size. By doing this, a faster rate of decomposition is ensured by having increased surface area available for improved microbial activity during composting. A smaller-than-normal particle size caused the feedstock to first become compacted, which increased the likelihood of anaerobic conditions being prevalent later on (because the water clogged the tiny air holes).

In contrast, larger particles processed a smaller surface area, making them less accessible to microbial action. They also created significant air pockets, which lowered the temperature of the matrix and caused the organic matter to decompose more slowly (Verma and Marschner, 2013). The waste particles sized at 25 mm yielded the finest disintegration and provided the right physical and chemical conditions for bioactivity during the tobacco composting process (Zhao *et al.,* 2017).

## Conclusion

A key component in enhancing the soil's structure is compost. Increased air penetration into the soil enhances drainage and lessens erosion. Because compost holds more water, it prevents the soil from drying up during droughts. Composting is a biological process that turns organic wastes into a homogenous, plant-available material in a hygienic manner in the presence of oxygen, at the right temperature and moisture content. Microorganisms break down the intricate lignin, cellulose, and hemicellulose molecules during the composting process maintaining all the variables influencing compost preparation within the appropriate range is necessary for the quick and perfect preparation of compost.

## Acknowledgement

The authors would like to thank the funding sanctioned by Entrepreneurship Development and Innovation Institute (EDII) under the Innovation Voucher Programme (IVP) by Agrostar Company with the knowledge partner of Vels Institute of Science, Technology and Advanced Studies (VISTAS) for the proposal of composting of organic waste through effective microorganisms.

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