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Composting Process of Organic Waste by Organism Decomposers: A Review

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Abstract
Waste is the symbol of inefficiency of any modern society and a representation of misallocated resources. Municipal solid waste (MSW) is mostly organic waste that still environmental problem in many countries. MSW mostly consists of biodegradable organic compounds that are degraded in open surfaces. Degradation of MSW by composting is common processes. In natural all of organic waste in the surface of the earth would be degraded by many kind of organisms that similar to the composting process into humus. Food waste has been one of the major issues globally as it brings a negative impact on the environment and health. Rotting discharges methane, causing greenhouse effect and adverse health effects due to pathogenic microorganisms or toxic leachates that reach agricultural land and water system. The main activity of microorganisms in the pile that degradation was taken placed, the supply of nutrients such as oxygen, water, temperature of operation should maintain the growth and activities of microorganisms. Compost is rich in nutrients. Compost can be used in various ways, such as in gardens, landscaping, horticulture, urban agriculture, and organic farming.
Key words: *organic waste, decomposers, nutrients, compost, activities, organisms*

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I. INTRODUCTION

Waste is the symbol of inefficiency of any modern society and a representation of misallocated resources.[1] Organic wastes for example of MSW were generated mostly by house hold, industries, and public services. The quantity of MSW increases by increasing the population, industries and public services. Organic waste disposal in landfills has created various environmental issues, such as greenhouse gas emissions and leachate.[2]

The untreated of organic waste sink on the soil, discharges to land, water, or air that treat the environment or human health.[3,4] Soil contamination is a condition of the entry of one or many chemical, physical, and biological objects into the soil where they can damage the soil structure and make the plant difficult to adapt.

Environment waste will be cleaned-up by organisms who eats the waste properly. The decomposers play a critical role in the flow of energy through an ecosystem. They break apart dead organisms into simpler inorganic materials, making nutrients available to primary producers. In the living soil various organisms (microorganisms and fauna) that perform various activities for the life.

The process of decomposition and the breakdown of raw organic materials to finish compost, while decomposers break down dead, organic materials, detritivores- like millipedes, earthworms, termites- eat dead organisms wastes. Dead plant materials such as leaf litter and wood, animal carcasses, and feces. They perform a valuable service as earth's clean up crew. Without decomposers, dead leaves, dead insects, and dead animals would pile up everywhere.

More importantly, decomposers make vital nutrients available to an ecosystem's primary producers, usually plants and algae. Decomposers break apart complex organic materials into more elementary substances, water and carbon dioxide, plus simple compounds containing nitrogen, phosphorus, and calcium. All of these components are substances that plants need to grow.[5]

Some decomposers are specialized and break down only a certain kind of dead organism. Others are generalists that feed on lots of different materials. Decomposers return back nutrients to the soil or water, the producers can use them to grow and reproduce.[6]

Most decomposers are microscopic organisms, including protozoa and bacteria. Other decomposers are big enough to see without a microscope. They include fungi along with invertebrate organisms sometimes called *letritivores*, which include earthworms, termites, and millipedes.

The process of decomposition, the breakdown of raw organic materials to a finished compost. The decomposition of organic matter by biological action has been taking place in nature since life first appeared on our planet. Generally speaking, there are two processes that yield compost: anaerobic and aerobic decomposition.[7]

I.1 Decomposers

Decomposers play a critical role in the flow of energy through an ecosystem. They break apart dead organisms into simpler inorganic materials, making nutrients available to primary producers. Millipede detritivore while decomposers break down dead, organic materials, detritivores—like millipedes, earthworms, and termites eat dead organisms and wastes (Fig.1). Conversion of organic waste into high value compost benefits for sustainable crop productivity.[8]

A group of organisms called decomposers. Decomposers feed on dead things: dead plant materials such as leaf litter and wood, animal carcasses, and feaces. They perform a valuable service as Earth's clean up crew. Without decomposers, dead leaves, dead insects, and dead animals would pile up everywhere. Imagine what the world would look like! More importantly, decomposers make vital nutrients available to an ecosystem's primary producers—usually plants and algae. Decomposers break apart complex organic materials into more elementary substances: water and carbon dioxide, plus simple compounds containing nitrogen, phosphorus, and calcium. All of these components are substances that plants need to grow. Some decomposers are specialized and break down only a certain kind of dead organism. Others are generalists that feed on lots of different materials. Thanks to decomposers, nutrients get added back to the soil or water, so the producers can use them to grow and reproduce. Most decomposers are microscopic organisms, including protozoa and bacteria. Other decomposers are big enough to see without a microscope. They include fungi along with invertebrate organisms sometimes called detritivores, which include earthworms, termites, and millipedes. Fungi are important decomposers, especially in forests. Some kinds of fungi, such as mushrooms, look like plants. Instead, fungi get all their nutrients from dead materials that they break down with special enzymes (Fig. 1). The next time you see a forest floor carpeted with dead leaves or a dead bird lying under a bush, take a moment to appreciate decomposers for the way they keep nutrients flowing through an ecosystem.

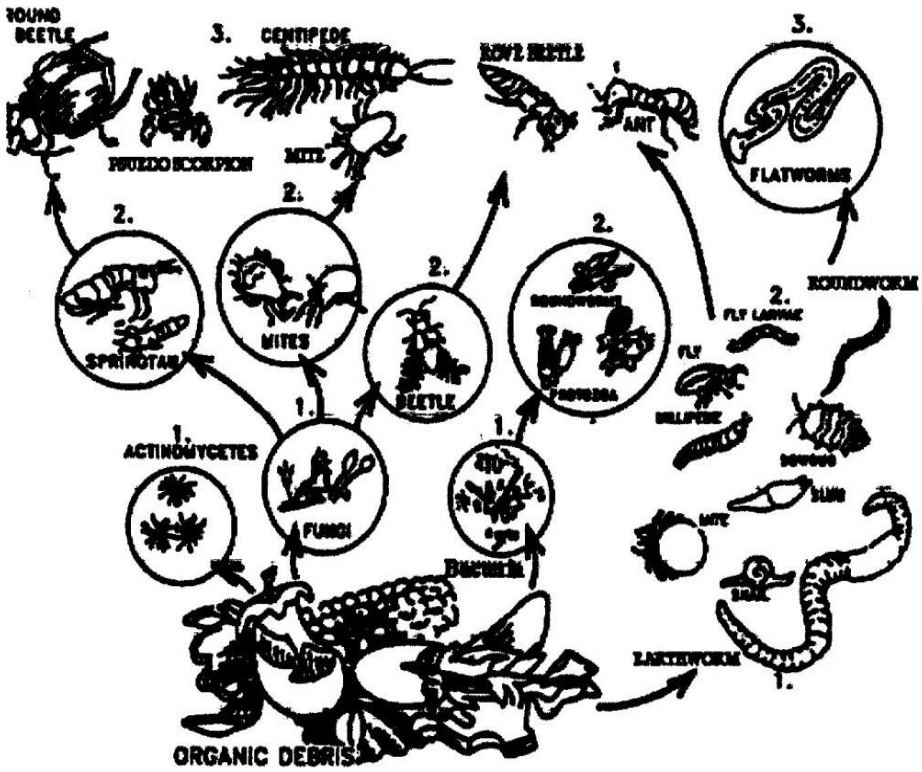

Fig. 1 Group of organisms in the breakdown process of composting of organic materials.[9]

II. ORGANIC WASTE DEGRADATION

There many type of wastes that are must be degraded in the soil, such as plastic materials, organic matter, detergent, pesticides, and metal content.[10] Organic wastes are come from biomass that the most abundant pollutant in the soil. The general sources of biomass are agricultural (food grain, straw, seed hulls, corn stalk, cattle manure, and poultry waste), forest (wood waste, bark or wood, trees, mill scrap, and sawdust), municipal (paper waste, sewage sludge, and food waste), energy (switch grass, willow, poplars, corn, canola, soybean, and other plant oils), and biological (animal waste, biological waste, and aquatic species.[11]

Municipal solid waste (MSW) can be proceeded into compost and liquid eco-enzyme. The composting process using organisms of decomposition, that they breakdown the complex organic materials into stable compost. It is a gradual complex process, in which both chemical and biological processes must occur in order for organic matter to change into compost. Organic waste or green waste can be defined as organic material that easy biodegradable.[12]

II.1 The Organisms of Composter

Decomposition of organic matter In the process of decomposition of organic materials of cellulolytic microbes secrete cellulose enzymes that play a role in accelerating the process of hydrolysis of cellulose and other polysaccharides. Decomposition of these materials will overhaul the physical properties of matter, and will release some nutrients, such as Nitrogen, Phosphat, Potassium, and Sulfur. Nutrient elements resulting from this decomposition process will be utilized by microorganisms to support their metabolism. Thus, the activity of microorganisms will increase, so that the process of decomposition and reshuffling of organic materials will progress more quickly.

This decomposition process will produce carbon, which is partially released in the form of simple sugars, while the remaining carbon is released into the air in the form of CO_2. Thus, the content of C (carbon) in the organic material becomes reduced, and the condition will automatically decrease the C/ N ratio. In the reshuffling of organic materials, unbranded cellulose, such as aquatic plant tissue without woody, paper or cotton paper waste will be more quickly decomposer, compared with lignin plants, especially woody plants. This is due to woody plants, cellulose and lignin will form lingo-celullose that is resistant to microbial activity. There are microbial communities have primarily focused on bacteria and fungi, while relatively little attention has been paid to the characteristics of protozoan communities.[13]

III. Decomposers activity in certain waste

Therefore, for composting of the ingredients of woody plant tissue, the role of lignin-producing microbial enzymes, such as *Paecilomyces sp., Allezcheria sp., Chaetomium sp., Poria sp., Nocardia sp., Streptomyces sp., Pseudomonas sp., and Flarocacterium sp.* Some types of earthworms include: *Pheretima, Periony and Lumbricus*. These three types of earthworms like organic materials derived from manure and plant debris. Worms have many uses, among others: helping to destroy organic matter that can affect the fertility of a soil, Animal Feed Material, Raw Material Drugs and ingredients for the cure of disease, Cosmetic Raw Materials and raw materials for some types of worms that can be consumed and beneficial to humans. Arthropod decomposers have a very important role in the decomposition process, especially in the soil. Dirt or feases from animals can lead to pollution of grasslands. Cattle feces left on the surface of the soil can kill or slow the growth of grass plants, and cause the plants around it less favored cattle. In addition, they can also place eggs for disease-carrying vectors, and are a living place for parasitic larvae in the ruminant digestive tract. However, with the presence of some species of beetles with fecal composition, they can be minimized.[14]

Some decomposers are specialized and break down only a certain kind of dead organism. Others are generalists that feed on lots of different materials. Nutrients get added back to the soil or water, so the producers can use them to grow and reproduce.

III.1 Chemical Decomposers

These organisms are the initial inhabitants of the pile. Many of them are unseen and come in with the materials that make up the pile. These organisms are around all of the time and only need to find the conditions right in order to start their normal functions of breaking down organic materials (Fig. 2).

Microbes are important decomposers of organic waste. By decomposing of organic waste and using it for their growth. Microbes play an important role in maintaining ecosystem’s carbon and nitrogen cycle. It is recommended to use microbes that are capable of decomposing complex organic matter.[15]

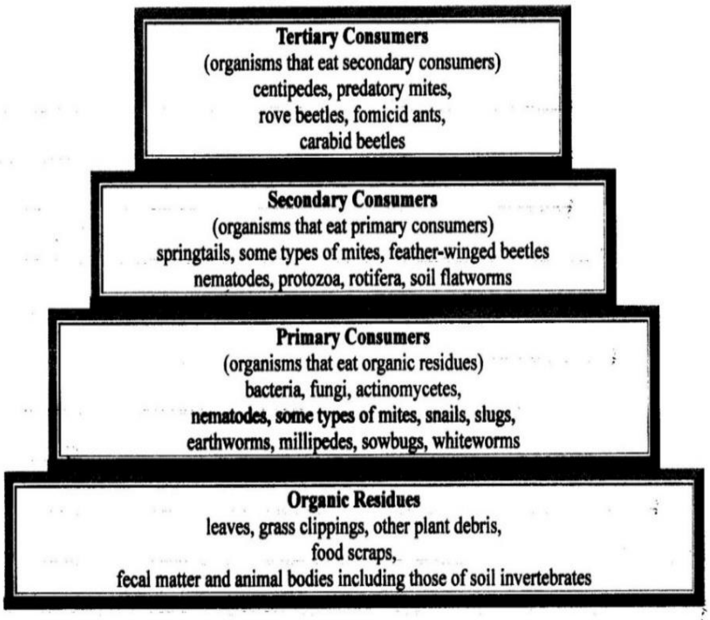

Fig.2 A Cascade degradation of organic residues in the decomposers activity. [16]

III.1.1 Bacteria

Bacteria lived in the soil play a vital role in recycling the carbon and nitrogen needed by plants. Microbes are important decomposers of organic waste. By decomposing organic waste and using it for their growth, microbes play an important role in maintaining ecosystem's carbon and nitrogen cycles.[15] An ecosystem's microbial shift may disturb it's carbon/nitrogen cycle as a result of any climate change or humanitarian factors, but heat produced by various instruments and greenhouse gases contribute significantly to global warming which in turn may be related to microbial shift of ecosystems. More importantly, decomposers make vital nutrients available to an ecosystem's primary producers—usually plants and algae. Decomposers break apart complex organic materials into more elementary substances: water and carbon dioxide.

Bacteria likely to be found in a compost heap are aerobic bacteria that specialize in breaking down organic compounds and thrive in temperatures ranging up to 170°F (77°C). Bacterial populations differ from pile to pile, depending upon the raw materials of the compost, degree of heat, amount of air present, moisture level, geographical location of the pile, and other considerations.

Most bacteria are color less and cannot make carbohydrates from sunshine, water, and carbon dioxide the way more complex green plants can. Some bacteria produce colonies; others are free-living. All reproduce by means of binary fission. In binary fission, the nucleus splits in two and a new cell wall grows crosswise over the middle of the cell. Each half contains one of the two nuclei, so that a new individual is produced from a single bacterial cell. Under the best conditions, a colony of bacteria can multiply into billions in a very short time. The life span of one generation of bacteria is about 20 to 30 minutes, so that one cell may yield a progeny of billions of individuals in half a day. these decomposition processes depend upon the different soil-inhabiting microbes. These microbes are the key components of agri-residue decomposition process.[5]

Bacteria are the most nutritionally diverse of all organisms, which is to say, as a group, they can eat nearly anything. Most compost bacteria are heterotrophic, meaning that they can use living or dead organic materials. Some are so adaptable that they can use more than a hundred different organic compounds as their source of carbon because of their ability to produce a variety of enzymes. Usually, they can produce the appropriate enzyme to digest whatever material they find themselves on. In addition, respiratory enzymes in the cell membrane make aerobic respiration possible as an energy source for compost bacteria. Since bacteria are smaller, less mobile and less complex than most organisms, they are less able to escape an environment that becomes unfavorable. A decrease in the temperature of the pile or a sharp change in its acidity can render bacteria inactive or kill them. When the environment of a heap begins to change, bacteria that formerly dominated may be decimated by another species.[17]

III.1.2 Actinomycetes

The characteristically earthy smell of newly plowed soil in the spring is caused by *actinomycetes*, a higher form of bacteria similar to fungi and molds. *Actinomycetes* are especially important in the formation of humus. While most bacteria are found in the top foot or so of topsoil, *actinomycetes* may work many feet below the surface. Deep under the roots they convert dead plant matter to a peat-like substance. While they are decomposing animal and vegetable matter, *actinomycetes* liberate carbon, nitrogen and ammonia, making nutrients available for higher plants. They are found on every natural substrate, and the majority are aerobic and mesophilic.

Five percent or more of the soil's bacterial population is comprised of *actinomycetes.* The reason bacteria tend to die rapidly as *actinomycetes* populations grow in the compost pile is that *actinomycetes* have the ability to produce antibiotics, chemical substances that inhibit bacterial growth. Inoculation at different phases of composting improved cellulose activities, accelerated the degradation of cellulose. The results revealed that inoculation at different phases of composting improved cellulase activities, accelerated the degradation of cellulose, increased the content of humic substances and influenced the structure of *actinomycetic* community.[18]

III.1.3.Protozoa

Protozoa are the simplest form of animal organism. Even though they are single-celled and microscopic in size, they are larger and more complex in their activities than most bacteria. A gram of soil can contain as many as a million protozoa, but a gram of compost has many thousands less, especially during the thermophilic stage. Protozoa obtain their food from organic matter in the same way bacteria do, but because they are present in far fewer numbers than are bacteria, they play a much smaller part in the composting process.[19] Protozoan community is a key of ecological factors in litter decomposition and nutrient cycling in mining areas.[13] These effects are likely due to an increased N content in barley plants and consequently increased nitrogen availability to aphids.

III.1.4.Fungi

A diverse spectrum of organisms, such as fungi, bacteria, and *actinomycetes*, can degrade and transform organic matter, including wood, into valuable nutrients. Fungi are many-celled, filamentous or single-celled primitive plants. Unlike more complex green plants, they lack chlorophyll, and, therefore, lack the ability to make their own carbohydrates. Most of them are classified as saprophytes because they live on dead or dying material and obtain energy by breaking down organic matter in dead plants and animals. Like the *actinomycetes, fungi* take over during the final stages of the pile when the compost has been changed to a more easily digested form. The best temperature for active fungi in the compost heap is around 70° to 75°F though some thermophilic forms prefer much greater heat and survive to 120°F.

A diverse spectrum of organisms, such as fungi, bacteria, and *actinomycetes* can degrade and transform carbonic matter, especially fungi has potentially be used in toxic substrate such as *Berkandera adusta, Phanerochaete chysosporium, and Trametes versicolor* to apply in composting wood waste contamining toxic substances such as pentachlorophenol, lindane, and polycyclic aromatic hydrocarbons. [20]

III.2 Physical Decomposers

The larger organisms that chew and grind their way through the compost heap are higher up in the food chain and are known as physical decomposers. The following is a rundown of some of the larger physical decomposers that you may find in nearly any compost heap. Most of these creatures function best at medium or mesophilic temperatures, so they will not be in the pile at all times.

III.2.1.Mites

Mites are related to ticks, spiders, and horseshoe crabs because they have in common six leg-like, jointed appendages. They can be free living or parasitic, sometimes both at once. Some mites are small enough to be invisible to the naked eye, while some tropical species are up to a half-inch in length. Mites reproduce very rapidly, moving through larval, nymph, adult and dormant stages. They attack plant matter, but some are also second level consumers, ingesting nematodes, fly larvae, other mites and springtails.[21]

III.2.2.Millipedes

The wormlike body of the millipede has many leg-bearing segments, each except the front few bearing two pairs of walking legs. The life cycles are not well understood, except that eggs are laid in the soil in springtime, hatching into small worms. Young millipedes molt several times before gaining their full complement of legs. When they reach maturity, adult millipedes can grow to a length of 1 to 2 inches. They help break down plant material by feeding directly on it.[22]

Most millipedes are scavengers, and they like eating decayed things. They commonly feast on damp and decaying or rotting wood, manure, grass clippings, and decaying fruits. If they have no access to anything decaying to eat, they will eat plants, fungi, and normal fruits.[23]

III.2.3.Centipedes

Centipedes are flattened, segmented worms with 15 or more pairs of legs, 1 pair per segment. They hatch from eggs laid during the warm months and gradually grow to their adult size. Centipedes are third level consumers, feeding only on living animals, especially insects and spiders. The sowbug is a fat-bodied, flat creature with distinct segments. In structure, it resembles the crayfish to which it is related. Sowbugs reproduce by means of eggs that hatch into smaller versions of the adults. Since females are able to deposit a number of eggs at one time, sowbugs may become abundant in a compost heap. They are first level consumers, eating decaying vegetation.[24] It was rare you'd see a grub or a centipede but nowadays all that's in the bins is centipedes and ants.

III.2.4.Snails and Slugs

Slugs usually feed on living plant matter, but they also like plant debris and fresh garbage. Slugs are the experts at breaking down organic matter, thus contributing to the process of decomposition.[25]

Both snails and slugs are mollusks and have muscular disks on their undersides that are adapted for a creeping movement. Snails have a spirally curved shell, a broad retractable foot, and a distinct head. Slugs, on the other hand, are so undifferentiated in appearance that one species is frequently mistaken for half of a potato. Both snails and slugs lay eggs in capsules or gelatinous masses and progress through larval stages to adulthood. Their food is generally living plant material, but they will attack fresh garbage and plant debris and will appear in the compost pile. It is well, therefore, to look for them when you spread your compost, for if they move into your garden, they can do damage to crops.

Slugs and snails are natures clean-up crews and recyclers. Slithering around under cover of darkness they feed on (and process as a result) garden debris, fungi and rotting vegetation. They have also been observed feeding on the excrement and carcases of other animals slugs and snails are natures clean-up crews and recyclers. slithering around under cover of darkness they feed on (and process as a result) garden debris, fungi and rotting vegetation. They have also been observed feeding on the excrement and carcases of other animals.

Slugs will feed on almost anything in the garden—look for holes and ragged edges on leaves and stems. The holes should have irregular shapes due to the slugs' file-like mouthparts. Small seedlings can be consumed entirely. Slugs can digest tissues from most plants, but you might find them especially liking plants with broad, delicate leaves, like beans, lettuce, cabbage, bokchoy, and tomatoes.[26]

III.2.5.Spiders

Spiders, which are related to mites, are one of the least appreciated animals in the garden. These eight-legged creatures are third level consumers that feed on insects and small invertebrates, and they can help control garden pests. White Tail spider bites typically result in temporary symptoms such as pain, swelling, and redness. Spiders have eight legs and insects have only six. Not all spiders make webs, but they all have the ability to produce silk. it is more a fear of everything to do with spiders - sticky, creepy webs, dark places and damp, scary basements.[27]

III.2.6.Springtails

Springtails are very small insects, rarely exceeding one-quarter inch in length. They vary in color from white to blue-grey or metallic and are mostly distinguished by their ability to jump when disturbed. They feed by chewing decomposing plants, pollen, grains, and fungi.

Springtails in soil are good because they help keep a well-balanced soil biome. Some Springtails feed on microbes, keeping their numbers in check. In contrast, other Springtails break down organic matter in the soil, making nutrients available to plants. However, large numbers of Springtails can be problematic. Springtails are a good sign for living soil because they play an essential role in the cycle of life in the soil biome. Springtails help the soil in a variety of ways. The predatory Springtails add value by keeping other soil microbes under control. This prevents them from creating an imbalance in the ground.[28]

III.2.7.Beetles

The rove beetle, ground beetle, and feather-winged beetle are the most common beetles in compost. Feather-winged beetles feed on fungal spores, while the larger rove and ground beetles prey on other insects as third level consumers. Beetles are easily visible insects with two pairs of wings, the more forward-placed of these serving as a cover or shield for the folded and thinner back-set ones that are used for flying. A beetle's immature stage is as a soft-skinned grub that feeds and grows during the warm months. Once grubs are full grown, they pass through a resting or pupal stage and change into hard-bodied, winged adults. Most adult beetles, like the larval grubs of their species, feed on decaying vegetables, while some, like the rove and ground beetles, prey on snails, insects, and other small animals. The black rove beetle is an acknowledged predator of snails and slugs. Some people import them to their gardens when slugs become a garden problem.

It was found that the capability of rhinoceros beetle larvae composts on the soil chemical properties have a similar effect with vermicompost. It made the insect compost are potentially beneficial for farm and can be profitable if commercially produced.[29]

III.2.8.Ants

Ants feed on a variety of material, including aphid honeydew, fungi, seeds, sweets, scraps, other insects, and sometimes other ants. Compost provides some of these foods, and it also provides shelter for nests and hills. They will remain, however, only while the pile is relatively cool. Ants prey on first level consumers, and may benefit the composting process by bringing fungi and other organisms into their nests. The work of ants can make compost richer in phosphorus and potassium by moving minerals from one place to another. Since ants have the ability to harbour and subsequently transfer pathogenic or toxigenic microorganisms, ants may act as disease vectors and contaminate food, water and food- contact surfaces of kitchens resulting in food- borne illnesses.[30]

Ants were associated with carrion in a wide range of habitats on almost every continent. Ants directly affected decomposition by feeding on carcasses and by lacerating carcasses. Ants indirectly affected decomposition by predating carrion feeding invertebrates and by altering the microhabitat of carrion via nest and mound construction.[31] This is an essential ecosystem process and a key energetic link between higher trophic levels, decomposers and primary producers. We used the removal of carbohydrate, protein and seed baits as a proxy to quantify the contribution that ants, other invertebrates and vertebrates make to the redistribution of nutrients around the forest floor.[32]

III.2.9.Flies

Many flies, including black fungus gnats, soldier flies, minute flies, and houseflies, spend their larval phase in compost as maggots. Adults can feed upon almost any kind of organic material. All flies undergo egg, larval, pupal, and adult stages. The eggs are laid in various forms of organic matter. Houseflies are such effective distributors of bacteria that when an individual fly crawls across a sterile plate of lab gelatin, colonies of bacteria later appear in its tracks.[33]

You can see how during the early phases of the composting process, flies provide ideal airborne transportation for bacteria on their way to the pile. If you keep a layer of dry leaves or grass clippings on top of your pile and cover your garbage promptly while building compost, your pile will not provide a breeding place for horseflies, mosquitoes, or houseflies which may become a nuisance to humans. Fly larvae will not survive the thermophilic temperatures in the well-managed compost pile. Mites and other organisms in the pile also keep fly larvae reduced in number. However, though many flies die with the coming of frost, the rate of reproduction is so rapid that a few survivors can repopulate an area before the warm season has progressed very far. Worms Nematodes or eelworms, free-living flatworms, and rotifers all can be found in compost. Nematodes are microscopic creatures that can be classified into three categories: those that live on decaying organic matter; those that are predators on other nematodes, bacteria, algae, protozoa, etc.; and those that can be serious pests in gardens where they attack the roots of plants. Flatworms, as their name implies, are flattened organisms that are usually quite small in their free-living form. Most flatworms are carnivorous and live in films of water within the compost structure. Rotifers are small, multicellular animals that live freely or in tubes attached to a substrate in the pile. Their bodies are round and divisible into three parts, a head, trunk, and tail. They are generally found in films of water and many forms are aquatic. The rotifers in compost are found in water which adheres to plant substances where they feed on microorganisms.

Degraded organic waste can be used as feed for natural insects, especially in the larvae phases. Food use to metabolism the body of maggot into mature, and then mature maggot harvested and use as poultry feed. Undigested feed is rejected to environment as a compost. Black soldier fly larvae (BSFL) can able to degrade and consume organic waste that can reduce animal or poultry dung.[34] BSFL its self can be able directly consume the degraded organic waste, while mature BSF live itself without feed. During larvae stage, insect consumes a large quantity of food the lighter perpupa weight (as a reserve for adult stage. The weight of larvae highly depends on the composition of food. Protein enhanced to produce heavier larvae which explained.[35] Factors influence in the production of maggot such as humidity, temperature, nutrition and odors of materials to be fermentation. [36]

III.2.10.Earthworms

The bacteria are the champion microscopic decomposers, then the heavyweight champion is doubtlessly the earthworm. Pages of praise have been written to the earthworm, ever since it became known that this creature spends most of its time tilling and enriching the soil. The great English naturalist, Charles Darwin, was the first to suggest that all the fertile areas of this planet have at least once passed through the bodies of earthworms. The earthworm consists mainly of an alimentary canal which ingests, decomposes, and deposits casts continually during the earthworm's active periods. As soil or organic matter is passed through an earthworm's digestive system, it is broken up and neutralized by secretions of calcium carbonate from calciferous glands near the worm's gizzard. Once in the gizzard, material is finely ground prior to digestion. Digestive intestinal juices rich in hormones, enzymes, and other fermenting substances continue the breakdown process. The matter passes out of the worm's body in the form of casts, which are the richest and finest quality of all humus material.[37]

Fresh casts are markedly higher in bacteria, organic material, available nitrogen, calcium and magnesium, and available phosphorus and potassium than soil itself. Earthworms thrive on compost and contribute to its quality through both physical and chemical processes, and reproduce readily in the well-managed pile. Since earthworms are willing and able to take on such a large part in compost making, it is the wise gardener who adjust his composting methods to take full advantage of the earthworm's special talents.[38]

IV. Maintaining environment of the organisms in order to life well

In order the decomposition process meets the efficient of decomposition. Decomposition of organic material in the compost pile depends on maintaining microbial activity. Any factor which slows or halts microbial growth also impedes the composting process. Efficient decomposition occurs if aeration, moisture, particle size, and a sufficient source of carbon and nitrogen are in evidence.

IV.1 Oxygen

The physical requirements that are optimal for bacterial growth vary dramatically for different bacterial types. Oxygen is required for aerobic microbes to decompose organic wastes efficiently. Some decomposition occurs in the absence of oxygen (anaerobic conditions); however, the process is slow, and foul odors may develop. Because of the odor problem, composting without oxygen is not recommended in a residential setting unless the process is conducted in a fully closed system. Mixing the pile once or twice a month provides the necessary oxygen and significantly hastens the composting process. A pile that is not mixed may take three to four times longer to decompose.

Raising the pile off the ground allows air to be drawn through the mass as the material decomposes. Coarse materials should be placed on the bottom as the pile is built or placed in the pile and removed after the decomposition starts. Oxygen levels should be kept at 5% throughout the entire pile. Typical oxygen percents range from 6% – 16% in the pile air spaces or in the exhausted air; and 20% at the exposed portions of the pile. Failure to keep all parts of the compost pile above the 5% oxygen level will cause the pile to go anaerobic, with the accompanying odor problems. The more oxygen, up to at least 10-12 percent, the more quickly the biodegradation will take place. Total inhibition is reached only for 3.26% and 6.61% respectively for *C. sporogenes* and *C. perfringens.*[39]

IV.2.Moisture

Moisture is essential for microbial activity. A dry compost will not decompose efficiently. Proper moisture encourages the growth of microorganisms that break down the organic matter into humus. If rainfall is limited, water the pile periodically to maintain a steady decomposition rate. Add enough water so the pile is damp. Excess water can lead to anaerobic conditions which slow down the degradation process and cause foul odors. If the pile should become too wet, turn it to dry it out and restart the process.

The relationships between soil moisture and the growth and development of microorganisms. It was found that the most optimum soil moisture for the development of *organotrophic* bacteria was the one at the level of 20% of maximum water capacity (MWC). For *Azotobacter spp*. bacteria and *actinomycetes*, the 40% MWC soil moisture level was optimum, while fungi developed the best at the soil moisture level of 60% of MWC.[40]

IV.3. Particle size

Decomposition occurs primarily on or near the surfaces of particles, where oxygen diffusion into the aqueous films covering the particle is adequate for aerobic metabolism, and the substrate itself is readily accessible to microorganisms and their extracellular enzymes. Small particles have more surface area per unit mass or volume than large particles, so if aeration is adequate small particles will degrade more quickly.

Grinding the organic material before composting greatly reduces decomposition time. The smaller the size of the organic refuse particle, the more quickly it can be consumed by the microbes. A shredder is useful for chipping or shredding most landscape refuse and is essential if brush or sticks are to be composted. composting is a necessary evil and with aerated static pile composting being used at a number of facilities accepting food waste.[41]

A low-cost method of reducing the size of fallen tree leaves is to mow the lawn before raking. Windrowing the leaves into long narrow piles one foot high will make the shredding process more efficient. If the mower has an appropriate bag attachment, the shredded leaves can be collected directly. However, grinding is entirely optional.

The antibacterial effect of ZnO nanoparticles is tested against *Staphylococcus aureus*, a Gram-positive pathogenic bacterium, from a particle-size, concentration, and surface-defects point of view. Smaller-sized particles are more effective inhibitors of bacterial activity when used in a certain optimum concentration.[42]

IV.4.Temperature

Temperature affects many life processes, but its effect might be expected to differ among eukaryotic organisms inhabiting similar environments. Temperature of the compost pile is very important to the biological activity taking place. Low outside temperatures slow the activity down, while warmer temperatures speed up decomposition. The microbes that make up the bulk of the decomposition process fall into two categories: mesophilic, those that live and function in temperatures of 50 to 113°F, and thermophilic, those that thrive at temperatures between 113 to 158°F. A well-mixed, adequately working compost pile will heat to temperatures between 110°F and 160°F as the microbes actively feed on the organic materials. These high temperatures will help destroy weed seeds and disease organisms within the pile.[43] The growth temperatures of eukaryotic algae range from −7°C for Antarctic algae to 56°C for *Cyanidiophyceae* algae living in hot springs. Many algal species live at relatively low temperature.[44]

IV. CONCLUSION

Food waste has been one of the major issues globally as it brings a negative impact on the environment and health. Rotting discharges methane, causing greenhouse effect and adverse health effects due to pathogenic microorganisms or toxic leachates that reach agricultural land and water system. Waste is such as eggshells, fruits, and vegetables, flowers and plants, rice and beans, dairy products, meat, poultry and seafood, bones, paper products, milk cartons, tea bags, coffee grounds, tea/coffee filters, garden waste are considered as organic wastes. These wastes can be converted into compost, fertilizers, soil and can be used to produce energy or fuel. Composting turns rotting garbage into a valuable soil enhancer that helps plants thrive.

Organic waste in the surface of earth must be degraded immediately by organisms decomposers to recycle the nutrients on earth. The organic matter in the waste can be broken down into carbon dioxide, water, methane, or simple organic molecules by microorganisms and other living things by composting, aerobic digestion, anaerobic digestion, or similar processes is known as biodegradable waste. In the process of composting, various types of organic materials also considered to be waste products, are recycled after which the soil conditioner or compost is produced. Compost is rich in nutrients. It can be used in various ways, such as in gardens, landscaping, horticulture, urban agriculture, and organic farming. The presence of different types of microorganisms is influenced by the composition of composite mixtures and changes in temperature through the phases of the composting process.

Organic residues such leaves or other plant materials are eaten by some types of invertebrates such as millipedes, sow bugs, snails and slugs. These invertebrates shred the plant materials, creating more surface area for action by fungi, bacteria, and *actinomycetes*, a group of organisms intermediate between bacteria and true fungi, which are in turn eaten by organisms such as mites and springtails. Many kinds of worms, including earthworms, nematodes, red worms and *potworms* eat decaying vegetation and microbes and excrete organic compounds that enrich compost.

The most important factors influencing the decomposition success are C/N ratio, humidity, temperature, substrate particle size, pH, oxygen content and microorganisms. Microorganisms such as *bacteria, fungi*, and *actinomycetes* act as chemical decomposers in the process of decomposition of organic matter into carbon dioxide, heat, water, hummus, and a relatively stable final organic product compost. In the process of composting, microorganisms decompose the complex molecules of lignin, cellulose, and hemicellulose. Cellulosic materials play a critical role when organic wastes are composted to produce a beneficial amendment for topsoil.

Waste disposal agencies wanting to avoid methane emissions from the anaerobic fermentation of waste, and farmers and horticultural is to who can use the composted products for agricultural benefits. Application of compost reduces the need for applications of fertiliser, water, herbicide and pesticide, and it reduces soil erosion. Additionally, carbon sequestration increases directly through the compost material and indirectly through increased biomass of plant root systems.

There may be increased water repellence of the soil from a build up of soil organic carbon. Compost may be a possible source of fungal and other diseases to plants and humans. Their tunneling aerates the compost, and their feeding increases the surface area of organic matter for microbes to act upon. As each decomposer dies or excretes, more food is added to web for other decomposers.

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