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Original Research Article

Compare and Contrast Various Composting Techniques to Examine the Impact of Composting on the Environment

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Abstract

Composting is a technology for recycling organic materials in order to achieve enhanced agricultural production. Composting proceeds under controlled conditions in compost heaps and pits (Müller-Sämann, 1986). Heaps should have a minimum size of 1 m3 and are suitable for more humid environments where there is potential for watering the compost. The ratio of C to N in the compost pile is important for optimizing microbial activity. In this article, we will compare and contrast various composting techniques to examine the impact of composting on the environment. The composting process is impacted by temperature, Different composting techniques have an impact on both the physical characteristics of compost and the chemical composition of compost. Additionally, it will analyze Carbon and Nitrogen ratio. Which will enable us to comprehend how composting affects the atmosphere.

Keywords: Composting, organic substrates, environment, heaps, carbon-nitrogen.

INTRODUCTION

Growing population and technology advancements raise human living standards, which increases the pace at which solid waste is produced. "India, with a population of more than 1.21 billion, is the second most populous nation in the world. Population growth occurs at a 3.09 percent yearly pace." Municipal authorities in India have been acknowledged as a third branch of government since the 74th amendment to the country's constitution was passed in 1992. The nation generates around 100,000 metric tonnes of trash overall (CPCB 2000). Waste generation will exceed 260 metric tonnes by 2047, according to a study by the Tata Energy Research Institute (TERI), which underlines the severity of the issue. Municipal agencies spend between 5 and 25 percent of their budget to managing municipal solid trash (MSWM).

In Indian cities, the average rate of collection for municipal solid waste (MSW) is about 70% (Sharholy 2008). The impact of local conditions is one of the main variables influencing the actual implementation of environmental biotechnology processes in MSWM. Because of this, contextual sensitivity is probably definitely the most crucial consideration when choosing a technology and has a significant impact on how widely adopted biotech procedures are likely to be (Evans 2003).

Open waste disposal encourages the growth of pests and disease-carrying insects including rats, cockroaches, flies, and mosquitoes (CPCB 2000). According to Bingemer and Crutzen's (1987) methodology, 50% of the carbon emissions in solid waste landfills are converted to methane. Waste reduction will be possible with the use of an appropriate scientific disposal technique (Manaf 2008).

Composting

By stabilising the organic wastes in the shortest amount of time, biological treatment is a highly efficient procedure for recovering waste materials and for avoiding the aforementioned issues in landfills. Composting is the biological decomposition and stabilisation of organic substrates in environments that permit the development of thermophilic temperatures due to biologically generated heat, with a final product that is sufficiently stable for storage and application to land without having a negative impact on the environment (Haug 1993). Composting's popularity has grown over the past ten years as a result of its numerous environmental advantages, including the quick conversion of organic solid waste into a biologically stable end product, efficient hygienization of pathogenic bacteria present in organic waste, stabilisation and volume reduction of waste materials prior to environmentally sound final disposal in landfills, and low cost and high efficiency of solid waste treatment (Bertoldi *et al*., 1988).

The original substrate's quality, the length of the processing period, and process management all affect the choice of composting technology. The kind of trash utilised determines the duration of the composting cycle (Saidi *et al*., 2008). Controlling the oxygen content in the exhaust air within a certain range might increase composting process efficiency and decrease the need for aeration (Xi *et al*., 2005). The major methods include windrow composting, forced aeration, and mechanical turnover in a reactor. "The windrow might be created in an open field or a shelter, and the reactors could be stationary or slowly revolving." Additionally, the procedure might be batch or continuous, however batch procedures are often used for large-scale composting (Benedict *et al*., 1986; Epstein *et al*., 1983; Sikora *et al*., 1983).

Since of the size, laboratory-scale testing is sometimes referred to as bench-scale testing because it can be comfortably conducted on a laboratory bench top. "These bench- and small-scale reactors, with volumes ranging from 0.4 to 16 litres, are useful for comprehending effects under ideal and meticulously regulated circumstances." Typically, pilot-scale testing deals with quantities that are bigger than laboratory-scale but less than full-scale. Studies on a small and pilot size only revealed temperature gradients (Kuter *et al*., 1985).

Composting has been used for a long time, and there are various instructions available for the creation of productive plants (Epstein 1997; Haug, 1993; Nakasaki *et al*., 1987; Finstein 1985; Kuter *et al*., 1985). The majority of these regulations relate to sewage sludge or municipal solid waste.

Components of compost mix

Both carbon and nitrogen are essential nutrients for the microbes, so make sure there's enough of both in the combined organic materials utilised. Chicken dung, which is rich in nitrogen, may be combined with hay, straw, leaves, or sawdust, all of which are high in carbon. Layers of these things are often used to construct compost heaps. The components are mixed by turning the mound. Composting manure that has been blended with bedding materials like sawdust or wood chips is possible. A material's typical carbon to nitrogen ratio of 25 to 40 makes composting easier (Fred Magdoff and Harold Van Es, 2009).

The wide variety of possible inputs makes it impossible to provide general guidelines for how much of each to add to the mix in order to achieve the desired moisture and carbon-to-nitrogen ratios (Fred Magdoff and Harold Van Es, 2009).

Formulas are available on Cornell University's website for composting concerns (http://cwmi.css.cornell.edu/composting.htm) to assist you determine how much of each element you'll need for your compost pile. There are instances when the pile is either too moist, too low in carbon to nitrogen (C: N), or too high in carbon to nitrogen (low in nitrogen). You may need to add more of one material or adjust the proportions of the others in your pile for it to be stable. In the first two circumstances, dry sawdust or wood chips may be used, and in the third scenario, nitrogen fertiliser can be added. A hose or sprinkler system may be used to supply water to a pile if it becomes too dry (Fred Magdoff and Harold Van Es, 2009).

Remember that different forms of carbon are accessible to different bacteria. Lignin resists breakdown in the environment. "High levels of carbon present as lignin may suggest that not all of the carbon will be accessible for quick composting, despite the fact that some lignin is destroyed during composting (likely dependent on variables such as the kind of lignin and the moisture content)." The effective C: N ratio may be much lower than suggested by utilising total carbon when leftovers include considerable levels of lignin (Table 5.1). For certain substances, the C:N ratio determined using total carbon vs that determined using solely biodegradable carbon does not change much (Fred Magdoff and Harold Van Es, 2009).

Certain elements should be avoided, including coal ash and, most notably, wood chips made from pressure-treated timber. Also, use caution when working with animal faeces or huge amounts of oils, fats, or waxes. It may be challenging to compost certain items, or the compost may include compounds that are harmful to plant growth (Fred Magdoff and Harold Van Es, 2009).

Wood chips or bark may be utilised as a ‘skeleton’ for effective aeration when employed as a bulking agent. By shaking the completed compost free of the bulking material, these components may be recycled for several more composting cycles (Fred Magdoff and Harold Van Es, 2009).

Table 1: Total vs. Biodegradable Carbon and Estimated C: N Ratios (T. Richard, 1996)

Material	% Carbon	C: N	% Carbon	C: N	% Lignin	% Cell Wall	% Nitrogen
	Total		Biodegradable				
Newsprint	39	115	18	54	21	97	0.34
Wheat straw	51	88	34	58	23	95	0.58

Material	% Carbon Total	C: N	% Carbon Biodegradable	C: N	% Lignin	% Cell Wall	% Nitrogen
Poultry manure	43	10	42	9	2	38	4.51
Maple wood chips	50	51	44	45	13	32	0.97

OBJECTIVES

- To assess the environmental impact of composting
- Analysis and evaluation of the current system for the recycling of biowaste with focus on composting in Agriculture.

RESEARCH METHODOLOGY

Composting is a natural way of recycling or degrading of organic waste including food waste, manure, leaves, etc. turning it into valuable and nutrient-full organic fertilizer. Composting is an example of a natural biological process that is carried out under controlled aerobic condition thus, requires oxygen. In the process, variety of microorganisms such as bacteria and fungi break down the organic materials into simpler substances. "The effectiveness of the composting depends on various factors namely: oxygen, temperature, moisture, size of the organic matter and the size and activity of microorganisms."

The composting process has four phases:

1. Latent phase – Colonization of microorganisms
2. Growth phase – Increase in temperature to mesophilic level
3. Thermophilic phase – Increase of temperature to the highest level
4. Maturation phase – Decrease of temperature to mesophilic level and subsequently to ambient level.

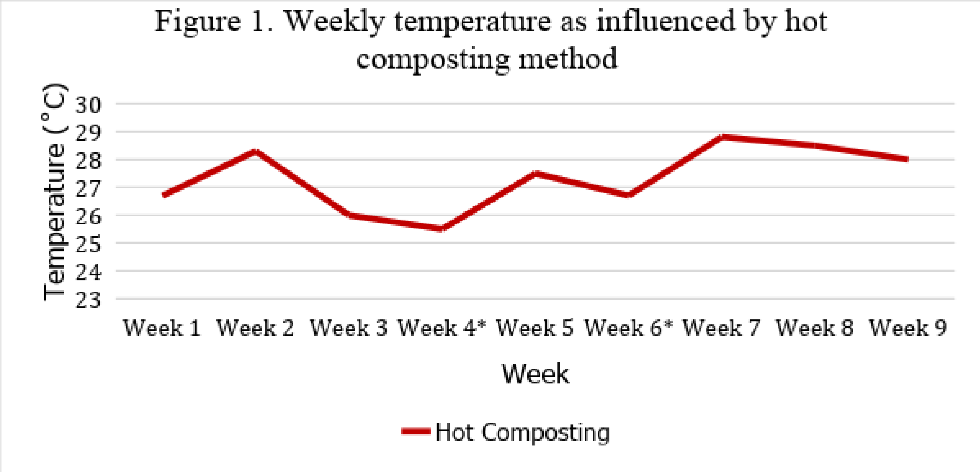
Humus, which is the naturally occurring form of decomposed organic matter without any recognisable traces of plants, bacteria, or animals, is the end product of a composting system. Compost that has been completed will be categorised as 100% organic fertiliser. It lessens compaction and increases soil porosity, drainage, aeration, and water holding capacity. Agriculture, horticulture, and landscaping all utilise compost. Additionally, it may be used to cover landfills and manage erosion.

Vermicomposting, IBS Rapid Composting, and Hot Composting are the three composting techniques that were developed. The tools and supplies needed for this project were compost bins, plastic covers, nets, binder clips, dried farm animal dung, fresh plant material (banana stalks, agricultural wastes), Trichoderma, earthworms (African night crawlers), hand trowels, knives, and wooden cutting boards. The students utilised a thermometer, a weighing scale, and a soil test kit to get the data.

The feedstock was made up of three parts brown and one part green, consisting of two parts dried animal dung and one part chopped fresh plant material. The plant components were minced, combined with a mixer, and weighed thereafter. The suggested CN ratio for the three compostes should be 30:1. All the components were combined, then the mixture was put in a composting bin (a plastic drum), and water was added. After all the raw materials were combined in the bin using the hot composting method, the bin was covered with plastic. While African night crawlers were introduced to vermicomposting and covered with a net, the IBS Rapid Composting technique included an extra 1 pack of Trichoderma before it was covered with plastic, inserted with 3 PVC pipes, and clipped to secure each side of the bin.

"Based on their related procedures, end results, and impact on radish growth and development, the three composting techniques were assessed." Data on the beginning temperature, physical characteristics (odour, colour, and particle size) and initial weight of all composts were documented over the two-month observation period of this activity. Vermicompost was stopped after one month of monitoring, and information about its ultimate weight and any physical characteristics were noted. IBS quick composting and hot composting were both given an extra month.

Raw materials adding compost



Implementation in the research area of composts

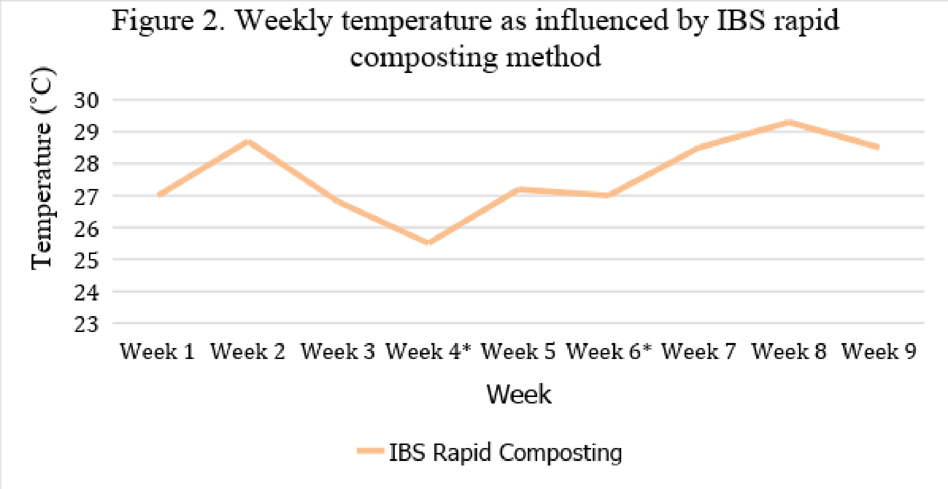
Seeds were sown in seedling trays to germinate and prepare for transplanting. Shallow holes were dig per plug for seeds should not be planted too deep in the soil. After a week, seeds that were sown in seedling trays were transplanted in the plot. Treatments imposed on the field are the following: control, with vermicompost, and with chicken manure. The land was plowed using a manual tractor and for each treatment a plot having a size of 1 m by 1 m with 0.5 spacing were designated for the transplants. Each plot has 9 transplanted seedlings of radish. All transplanted seedlings were covered with banana stalk. Application of vermicompost and chicken manure is done through basal application while no compost was added for the plot of control. Everyday watering of seedlings was done and weeds that surrounds each plot were removed. Furthermore, maintenance of each plots and observation for the presence of pests were also done. After the observation period of 2-3 months, radishes in the three plots were harvested and gathered data on number of leaves, leaf area (L*W) *0.75, leaf color, fresh weight, and marketable fresh weight.

Planted with compost treatments

RESULT AND DISCUSSION

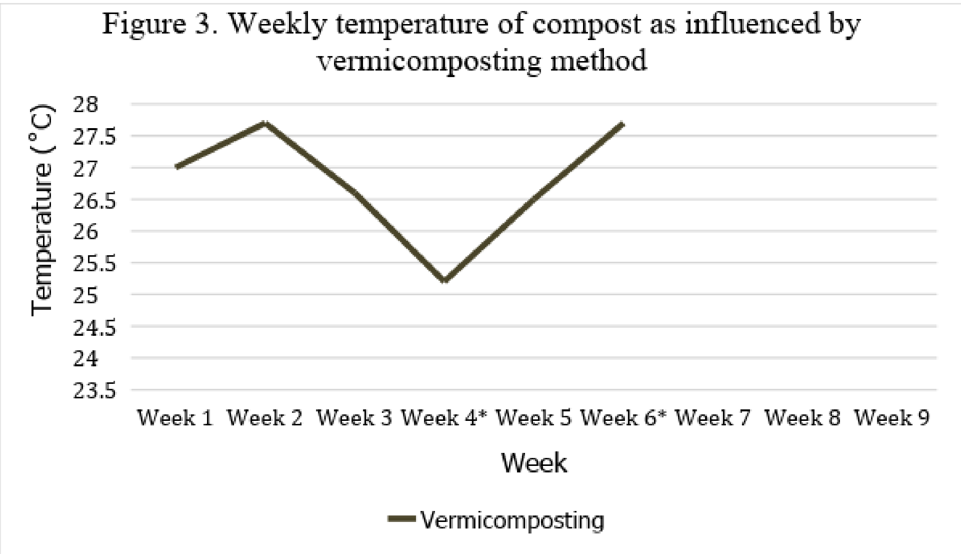
Composting Methods

Temperature affects the composting process. It involves the mesophilic and thermophilic temperature ranges. The higher the temperature the more it destroys pathogens in the compost where turning and aeration regulates temperature. The three composts temperature were recorded every week of Monday and Thursday. It is expected to increase after 24 hours. However, increased in temperatures were not observed. The reason and problems encountered will be discussed below.



A temperature rise is expected in hot composting method. This high temperature will effectively kill the weeds and seeds present in the heap. Factors that may contribute to the almost constant low temperature is the recommended size of the bin. According to Compost Education Center (2015), the hot compost pile is not should lower than one cubic meter in order to attain and maintain the temperature for hot composting (55 °C). The first six to ten inches from the side of the container functions as insulator and the main decomposition activity occurs at the center of the pile. It is important to monitor the temperature of the pile at least once a day to check if it is heating up or not rising beyond 55 °C. Once the pile reaches 55 °C, then it is time for turning.

IBS Rapid composting method usually heats up within 24-48 hours from set-up. The temperature observed is much lower than the theoretical which is 50 °C or higher. This anomaly can be caused by too much moisture resulting to the compaction of the pile and maintained close temperature observations. Another factor is the activator fungus *Trichoderma*. It is possible that the fungus was not mixed thoroughly in the set-up thus, slower decomposition activity (FAO, 2003).



Vermicomposting method was terminated after a month. The temperature observed in the vermicompost set-up deviates from 25 - 28 °C, which is within the recommended temperature range of FAO. The vermicompost should have the temperature maintained between 20 to 27 °C because at higher temperature, the earthworms aestivate or spend a dry period and at lower temperature, the worms tend to hibernate (FAO, 2003). Highest productivity of the worms is attained within the recommended temperature range (Worm Composting Headquarters, 2019). Among the three set-up, vermicompost was once applied with water because the upper layer was observed to be dry as compared to the other two methods which has been applied with water and turned every once a week.

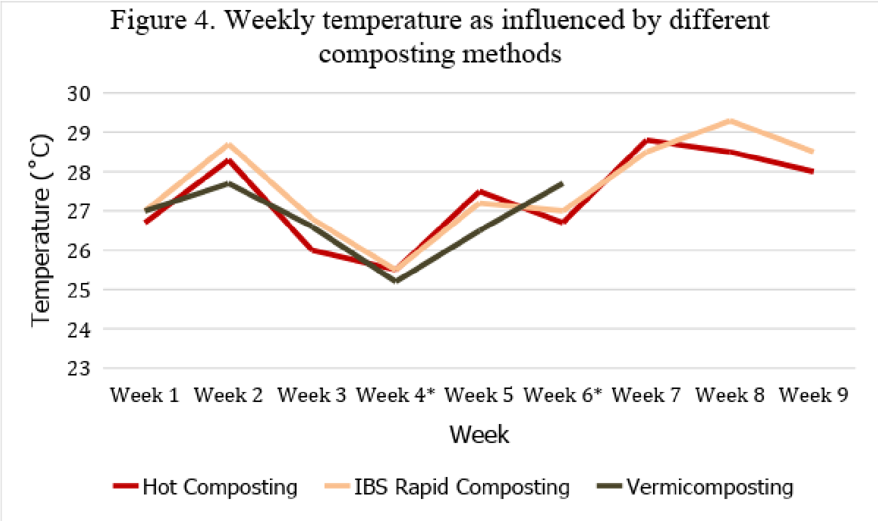


Figure 4 shows that after a decreased in temperature (Week 2 to Week 4) it increases from Week 4 for all composts. The reason for this was in this week the composts did not get any water. It can also be seen from the line starting at Week 6 (hot and IBS rapid composting). Thus, whenever the composts are left unwater it increased in temperature. It was very obvious in the vermicomposting method. As have said earlier, vermicomposting method was the first one to terminate after 1 month and during the 4th week of data gathering the only thing that was done is to record its temperature. Moreover, excessive application of water causes the compost pile in all compost to decrease its temperature.

Table 1: Physical characteristics of compost as influenced by different composting method

Composting Method	**Physical Characters**					
	Initial			Final		
	Odor	Color	Particle size/aggregate	Odor	Color	Particle size/aggregate
Hot Composting	foul odor	Brown and green	larger size of plant matter (dried & fresh)	odorless	Light brown	Smaller particles (soil-like)
IBS Hot Composting	foul odor	Brown and green	larger size of plant matter (dried & fresh)	odorless	Light brown	Smaller particles (soil-like)
Vermicomposting	foul odor	Brown and green	larger size of plant matter (dried & fresh)	odorless	black	Smaller particles (soil-like)

The activity of the organisms has an impact on the three composting methods' physical features. "In terms of odour, colour, and particle size, these components' initial and final physical attributes were comparable. Vermicomposting produced a different hue of finished product than hot or IBS fast composting, however." This is due to the presence of African night crawlers in vermicompost. The African night crawler, a creature, consumes the plant matter in the compost pile and excretes ‘casts.’ The ANC casts will then be turned into stable soil aggregates by the action of gums resulting from microbial decomposition of their organic contents (Waksman and Martin, 1939) or by the binding impact of fungal hyphae (Parle, 1963), which transforms it into excrement and turns the compost black.

Table 3: Chemical composition of compost as influenced by different composting method

	Hot Composting	**IBS Hot Composting**	**Vermicomposting**
pH	5.0	5.4	6.0
N	Medium	Medium	High
P	Low	Low	Low
K	Sufficient	Sufficient	Sufficient

The pH of the soil has an impact on the development and operations of microorganisms, claim Chen *et al.*, (2011). Additionally, it decides what happens to nitrogen compounds. Additionally, fungus and bacteria also like a pH range of 5.5 to 8.0. There will be a loss of gaseous ammonia at pH levels higher than 7.5. The pH of the resulting compost for hot composting typically falls between 6.5 and 7.5. "A mature compost's N, P, and K components differ in their nutrient release characteristics and plant availability." The ratios of the nutrients in a compost make the percentages of those nutrients important. This is due to the fact that nutrient ratios may influence plant development and nutrient absorption.

The mature compost produced by the IBS quick composting process typically has a pH range of neutral to alkaline. Compared to chemical fertiliser, it has less N, P, and K. 1991 (Cuevas).

The pH range for vermicomposting, on the other hand, is between 5.5 and 8.5, which is optimal for the activity of microorganisms and earthworms. The ideal pH, however, is neutral or nearly neutral. The pH levels of the feed substrate significantly alter during vermicomposting. During the vermicomposting of feed substrate, a low pH early phase is often seen. This results from the early production of carbon dioxide and volatile fatty acids. "The pH rises as the process continues due to the following evolution of CO_2 and use of volatile fatty acids (Kaushik and Garg 2004)." However, since chicken dung is so alkaline, it generates more heat and could harm earthworms. So, in order to encourage microbial activity, which results in the enrichment of important nutrients, amendment materials like plant litter are required (Gupta *et al.*, 2016). According to Blake and Hess (2001), chicken dung typically has a pH between 9 and 10. At pH 9–10, NH_3 and NH_4 are in balance with one another. Since the majority of NH_3 converts to NH_4 at pH 7.2 or below, lowering the pH of the feed may reduce the quantity of NH_3.

Graff noted in 1971 that the earthworm castings contained much more nitrogen than the surrounding soil. Additionally, earthworms were shown to deliver 3.4–4.1 g of mineral nitrogen to the soil via excretion, mucus formation, and soil consumption, according to Curry et al. According to Opperman *et al*., (1987), earthworm activity resulted in a net mineralization of nitrogen, while earthworm exclusion resulted in a net loss of mineral nitrogen. According to Bhatnagar and Palta (1996), worm excrement increased the amount of nitrogen (N) accessible to plants by roughly 6%.

Coleman *et al*., (1983) noted that the release of phosphorus compounds that may be cycled via plants and back to the soil biota may be caused by the absorption of bacteria and fungus, followed by earthworm secretion and decomposition. "Mansell *et al*., (1981) also noted that the earthworm increased the short-term plant availability of phosphorus taken from plant litter by two or three times." According to 1996 research by Bhatnagar and Palta, worm activity increased the amount of P accessible to plants by 15–30%. In 1992, Jambhekar found that various plant leftovers and agricultural waste had a noticeably higher availability of potassium than the original and control treatments.

Carbon and Nitrogen

Microbes use carbon as a source of energy. "While some of the carbon in aerobic decomposition is liberated as CO_2, the remaining carbon is coupled with nitrogen in the bodies of bacteria." As a consequence, a compost pile's carbon content is continually dropping. Nitrogen is continually recycled throughout the bodies of microbes and is utilised for the creation of biological components, amino acids, and proteins. When the bacterium dies, whatever nitrogen that was integrated into the cells becomes accessible once again. (2009) Aggie Horticulture

The high nitrogen source, such as grass clippings or other plant wastes, animal manures, food scraps, or other high nitrogen sources, may hasten decomposition and enhance the nitrogen content of the finished product, making it more appropriate for use as a soil supplement. Because too much nitrogen can lead to the formation of ammonia, which causes an odour issue, the high nitrogen component needs to be carefully controlled. The quick decay also depletes oxygen, which worsens the situation since anaerobic microbes take the place of the aerobic ones. (2009) Aggie Horticulture.

The ideal C/N ratio for composting is between 25 and 30:1. When mixing raw materials, it's crucial to produce a combination that comes close to this ideal and has the right properties for aerobic composting. A slower rate of decomposition will be the outcome of a greater C/N ratio. A lower ratio causes excessive nitrogen loss and, if the mixture is not often rotated, may cause smells. (2009) Aggie Horticulture.

The limiting nutrient will be carbon if the C/N ratio is too low due to the raw material's high nitrogen content. Unstable ammonia will occur if there is not enough carbon available to provide the microorganisms the energy they need to integrate nitrogen molecules into their cells. "The extra nitrogen will be removed as ammonia while all the carbon will be ‘eaten’ by the bacteria in that scenario." In 2007, the National Resources Conservation Service

Table 4: Weight of Compost as influenced by different composting method

Composting Method	Weight (kg)		
	Initial	Final	Undecomposed material (after sieving)
Hot Composting	45	7.2	4.15
IBS Rapid Composting	45	10	2.9
Vermicomposting	45	13.5	0.2

Among the three-composting method, vermicompost had the lowest amount of undecomposed material equivalent to 0.4% followed by IBS rapid compost and hot composting with 6.6% and 9%, respectively. In addition, vermicompost also had the highest percent final weight of 30% as compared to IBS rapid composting and hot composting method with 22% and 16%, respectively. The african night crawler is very efficient in composting the organic materials. It can be said that the environment of the vermicompost set-up is favorable to the worms. Another factor to mention for all the methods is the scattering of the soil during the transfer and filtering of the compost. This scattered compost was not included in the final weight of the three methods.

The aerobic composting mainly involves the decomposition of organic materials by different microorganisms present in the pile. The active composting generates heat and large amount of carbon dioxide (CO2) and water vapor are released in the atmosphere. This CO2 and vapor losses can amount more than half of the weight of the materials thus, reducing the final mass of the product. The presence of various organisms like mites, ants, etc., which act the physical decomposers, contributed as well in the reduction of the final weigh through digestion. These organisms directly feed on the organic materials in the compost (Young, Rekha and Arun, 2005).

Table 5: Days to maturity of compost as influenced by different composting method

Composting Method	Days to Mature
Hot Composting	60
IBS Rapid Composting	60
Vermicomposting	30

The difference on days to maturity of the three composting methods depends on the different factors such as the size of the material. During the mixing, it can be that the substances were not well mixed thus, having smaller pieces in one of the set up. The smaller the organic materials, the greater the surface area for microorganisms, the faster they can do their work. Another factor that contributed to the days to mature is the turning. Since composting is an aerobic process, it requires oxygen. Proper turning gives and distributes right amount of oxygen to the heap, supplying it to the microorganisms. In small scale basis, a compost matures for a week while it took a month for large scale compost production.

Compost from hot composting method is usually ready after 14-21 days (Deep Green Permaculture, 2010). IBS rapid composting involves the addition of the fungus *Trichoderma sp.* to the heap. The fungus is a good cellulose decomposer (FAO, 2003). According to the Food and Agriculture Organization (FAO), the duration of decomposition is 21-45 days. In vermicomposting, the addition of earthworms is done to decompose the organic materials. The compost is ready for about a month having black, granular appearance (FAO, 2003).

Research Area Application of Composts

Compost is a highly useful supplement in organic farming for keeping the soil's ability to contain water and nutrients. This is supposedly due to the nutrients and content of the compost. N, P, K, Ca, Mg, S, Mn, Cu, Zn, Cl, B, Fe, and Mo are all vital nutrients required for a healthy plant development, according to (Ahmad, A. A. *et al*., 2016), however the amount varies depending on the feed, supplements, medicines, and water taken by the animals. To increase agricultural yields and soil fertility, manure is applied. Additionally, adding manure improves the bulk density and porosity of soil and increases soil organic matter, but it must be properly composted. In light of this, the use of chicken manure as a soil supplement may help to solve the issue of inadequate nitrogen and organic matter levels. "But according to one research, chicken dung should be used together with phosphate fertiliser to prevent salinity increases caused by significant amounts of manure application (Gizachew, K.B. *et al*., 2018)." The sole drawback of using chicken manure is that, due to its pH range of 6.5 to 8.0, it is not suited for plants that dislike lime.

Nitrogen is abundant in earthworm castings from vermicompost, such as African night crawlers. Nitrogen is crucial for the development of plants and the generation of food since it is necessary for the cellular synthesis of enzymes, proteins, chlorophyll, DNA, and RNA. Nitrogen fertiliser boosts plant growth and leaf area, which in turn boosts light absorption and boosts chlorophyll synthesis [Joshi, R. et. al., 2014 as referenced by Ganeshnauth]. Although the vermicompost treatment had the lowest total leaf area, it provided enough nitrogen to promote the greatest level of chlorophyll synthesis. Vermicompost's hormone-like function, as reported by Bachman (2007; referenced by Ganeshnauth), promotes root initiation, root biomass, and improved plant growth and development. Vermicompost had the highest chlorophyll content and accelerated seed germination and growth. Humic acids, which boost plant growth and root biomass, are abundant in vermicompost.

In general, manure gives crops N, P, K, and micronutrients that are both readily accessible and ‘slow release.’ However, nutrients may be rapidly leached through soil profile if left on the surface because nutrient concentration is very changeable. Additionally, weed seeds and dangerous germs could be introduced. Compost has the benefit of being 50% to 75% less volume than manures, which makes it simpler to carry and apply. It is also dryer than manures. On a moist basis, it had a higher total concentration than dung. It also includes organic stuff, which gradually releases nutrients. Additionally, because of the heat produced during decomposition, the presence of beneficial bacteria boosts nutrient cycling and suppresses weed seeds as well as soil and foliar diseases. For a variety of markets and applications, including gardening, mine reclamation, seed starting, potting mixes for nurseries, and soil amendment for landscaping, it may be a potential source of income. However, depending on the amount of product and if compost is being sold, it may also need specialised permissions and expensive equipment. "likely more expensive than manure or fertiliser." Controlling nutrient-enriched leachate is necessary to avoid runoff or groundwater contaminating.

Table 6: Total fresh weight, marketable fresh weight, and percent marketable fresh weight influenced by different compost treatments

Treatments	Total fresh wg	Marketable fresh weight (g)	Percent marketable fresh weight (%)
Control	600	550	92
Vermicompost	650	590	91
Chicken manure	740	610	82

The treatment that had the highest percent marketable weight was control, followed by vermicompost, then chicken manure. "A consumer would not buy radish having broad leaves and with short root." They preferred long and large roots. However, the harvested crop had small and irregular size and shape of radishes. Going back to Figure 1 radish treated with vermicompost and without compost had the potential to be sold in market assuming that it has long and large roots after harvesting it.

Benefits of composting

- Suppress plant diseases and pests.
- Reduce or eliminate the need for chemical fertilizers.
- Promote higher yields of agricultural crops.
- Facilitate reforestation, wetlands restoration, and habitat revitalization efforts by amending contaminated, compacted, and marginal soils.
- Cost-effectively remediate soils contaminated by hazardous waste.
- Remove solids, oil, grease, and heavy metals from stormwater runoff.
- Capture and destroy 99.6 percent of industrial volatile organic chemicals (VOCs) in contaminated air.

Compostaenrichesasoils:

Poor soils may be rebuilt with the use of compost. Beneficial microorganisms, mostly bacteria and fungus, are produced during the composting process and break down organic material to produce humus. "Humus, a rich nutrient-filled substance, boosts the nutritional content of soils and aids in moisture retention." Compost has also been shown to control plant diseases and pests, lessen or completely remove the need for artificial fertilisers, and increase crop yields (Haug, 1993).

Compostahelpsacleanupa (remediate) contaminatedasoil:

Composting has been found to cure volatile organic compounds (VOCs), such as explosives, polyaromatic hydrocarbons (PAHs), and heating fuels, as well as smells and semi-volatile organic compounds (SVOCs). "Additionally, it has been shown to bind heavy metals and stop them from entering water supplies or being absorbed by plants." In polluted soils, the composting process breaks down and, in some circumstances, fully removes pesticides, chlorinated and non-chlorinated hydrocarbons, and wood preservatives (Haug, 1993).

Compostahelpsapreventapollution

When organic waste is composted instead of being dumped in landfills, less methane and leachate are created. Pollutants in stormwater runoff may be filtered out by compost before they reach waterways. Erosion and silting on embankments parallel to streams, lakes, and rivers may also be prevented using compost, as can erosion and grass loss on roadsides, hillsides, playing fields, andagolfacourses.a (Haug, 1993).

Usingacompostaoffersaeconomicabenefits

Composting may cut down on the amount of water, fertiliser, and pesticide used in a garden. "It's useful as a commodity and cheaper than conventional landfill cover and synthetic soil additions." By keeping organic waste out of landfills, composting helps cities save money and offers a more cost-effective option for cleaning up polluted soil (Haug, 1993).

Carbon-Nitrogen Ratio

When organic material starts to decompose, it is affected by two main factors, which are the presence of nitrogen and carbon in the amount that is going to be decomposed, the C:N ratio represents the proportion of the two elements in the amount that we have, living organisms that usually take place in decomposing organic material use the carbon as a source of energy, and thus, having the enough amount of carbon is required to have a sufficient energy to successfully decompose the needed amount, on the other hand, nitrogen is so important, since it is used by those organisms to build the cell structure, which is vital for the increase of the organisms cells working on the compost amount present, and hence, reducing the time significantly with the right amounts of both elements, carbon and nitrogen present in the surrounding environment, or the compost mix itself, mentioning that there are some organisms that use their inner Nitrogen to form new cells, and thus, burn more carbon, so the carbon amounts will be reduced more than the usually, and Nitrogen will somehow have a stable amounts, since it will be recycled by these organisms (Washington state university, 2011).

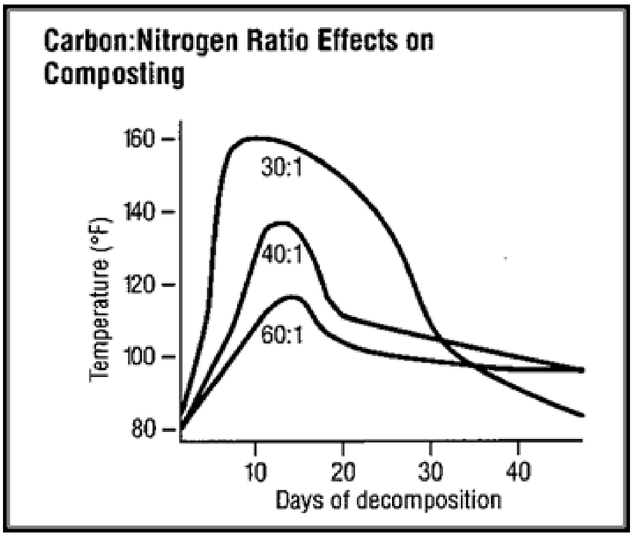


Fig 4: Nitrogen effect on compost (Washington state university, 2011)

For soils, the presence of high levels or amounts of carbon could be problematic because soil organisms will withdraw a proportional amount of nitrogen to that of carbon, to continue composition, a process known as "robbing" the soil of nitrogen, which causes problems and the soil not being able to give nutrients to plants (Washington state university, 2011).

There is no risk of nitrogen leaching from the soil above a C:N ratio of 20, where C and N are the available amounts. It is possible that the true C:N ratio is higher than 20, especially if a substantial portion of the carbon is present as lignin or another kind of recalcitrant substance. The carbon-to-nitrogen (C:N) ratio plays a crucial role in composting by limiting the amount of nitrogen lost to the soil and maximising the amount of nitrogen that can be preserved in the compost (Washington state university, 2011).

A C: N (available quantity) ratio of 30 encourages quick composting and would provide some nitrogen in an instantly usable form in the completed compost since organisms need around 30 parts carbons for each component of nitrogen. Researchers have found that values between 20 and 31 work best. In general, researchers assume little nitrogen loss for carbon to nitrogen ratios greater than 30. Research conducted at the University of California found that a C:N ratio of 30-35 was optimal for materials with starting C:N ratios ranging from 20 to 78 and starting nitrogen levels from 0.52% to 1.74%. The optimal carbon to nitrogen ratios that have been reported may contain unavailable carbon. If the carbon to nitrogen ratio is higher than 30 to 40, the composting process will take longer. Bacteria may get the C:N ratio as low as 10 if the amount of unavailable carbon is low enough. "Depending on the starting material, values between 14 and 20 are typical for humus." The tests demonstrated that nitrogen robbing would not be substantial when composting a material with a greater C:N ratio since the residual carbon is so slowly accessible (Washington state university, 2011).

Table: Estimated Carbon-to-Nitrogen Ratios

	C: N
Corn stalks	**75:1**
Fruit Waste	**35:1**
Leaves	**60:1**
Peanut shells	**35:1**
Coffee grounds	**20:1**
Grass clippings	**20:1**
Garden Waste	**30;1**

CONCLUSION

Vermicomposting, IBS Rapid Composting, and Hot Composting are the three types of composting. Trichoderma and African night crawlers have been added to IBS Rapid and vermicomposting, respectively. Temperature, physical qualities (colour, odour, and particle size), pH, weight, and days to maturity were taken into consideration while evaluating these composts. The ultimate weight of compost produced by the vermicomposting process was greatest, followed by IBS Rapid compost and Hot compost. Vermicompost also turns from brown to black, whereas the other processes turn from brown to light brown. There was no bad smell, and the particles were smaller (soil-like). Additionally, the temperature of the compost did not increase as a result of excessive watering, but it was noted that if the composts were left without water, the temperature increased. The size of the utilised container or bin, excessive wetness that causes compaction of the pile, and the ANC's propensity to hibernate in the case of vermicomposting are other variables that contribute to a consistent low temperature. The compost bin should be 1 m X 1 m in size to allow for temperature increase after 24 hours. Additionally, a 30:1 C/N ratio is advised in order to speed up compost decomposition. It shouldn't be higher or lower than this since doing so would alter the temperature and its breakdown as well as the microorganisms.

On the other hand, the growth parameters of chicken manure and vermicompost applied to soil vary. Compared to the other two treatments, chicken manure's total leaf area had wider leaves, but it also had the fewest leaves on average. Vermicompost treatment had the highest average number of leaves. Furthermore, research has shown that manure, including chicken dung, generally gives crops access to slow-releasing N, P, K, and micronutrients. Long-term utilisation of both vermicompost and chicken manure is possible via split application. However, vermicompost rather than chicken dung is more advised in order to avoid wide leaves. Additionally, lime-hating plants cannot utilise chicken dung due to its neutral to mildly alkaline pH. Additionally, vermicompost treatment has the second-highest percentage of marketable fresh weight.

Organic waste decomposition in landfills results in the production of methane, a very strong greenhouse gas. Methane emissions are considerably reduced when organic waste, including leftover food, is composted. Compost reduces, and in some instances entirely eliminates, the need for chemical fertilisers. Compost promotes higher crop yields in the agriculture sector. Compost may support initiatives to reforest, restore wetlands, and regenerate ecosystems by strengthening polluted, compacted, and marginal soils. The cost of using compost to clean up soils polluted by hazardous waste is low.

When pollution in the soil, water, and air has to be removed, traditional procedures might be more costly than compost. Water retention in soil is improved by compost. Carbon dioxide may be absorbed by compost.

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