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Organic waste to plant's gold by composting: A review

Ranju Gulati
DAV College Chandigarh, Chandigarh, India

Abstract
Composting has been used as a means of recycling organic matter back into the soil to improve soil structure and fertility. The composting process has received much attention in recent years because of pollution concerns and the search for environmentally sound methods for treating waste. Waste volumes continue to rise, which leads to loss of resources and increased environmental risks. Open dumping and sanitary landfill is a major method for waste disposal, the Land filling of biodegradable waste is proven to contribute to environmental degradation, mainly through the production of highly polluting leachate and methane gas. Composting aims to stabilization of waste for land filling, volume and mass reduction of solid waste and return of organic substances to the natural cycle. This paper reviews information on the composting for treating waste as a means of addressing the environmental pollution concerns.

Keywords: environmental pollution, solid waste and composting

Introduction

Landfill and incineration have until now been the most widely used means of solid waste disposal throughout the world, the land filling of biodegradable waste is proven to contribute to environmental degradation, mainly through the production of highly polluting leachate and methane gas. Methane constitutes one of the six greenhouse gases responsible for the global warming, which needs to be reduced, in order to tackle climate change under the [1]. The methane emissions from landfills constitute about 30% of the global anthropogenic emissions of methane to the atmosphere [2]. The problems are like hundreds of tons of biodegradable organic waste are being generated in cities and towns in the countries and creating disposal problems. Such as every day, grocery stores discard perishable products such as fruits, vegetables, bread, pastries, milk products, fish, seafood and other frozen products. The concept of recycling waste nutrients and organic matter back to agricultural land is feasible and desirable. Land application represents a cost-effective outlet for the producers of compostable wastes and a potential cheap source of organic matter and fertilizer elements for landowners. Composting is one of the most promising technologies to treat wastes in a more economical way, for many centuries composting has been used as a means of recycling organic matter back into the soil to improve soil structure and fertility. Composting is a natural process that turns organic material into a dark rich substance, this substance called compost is a wonderful conditioner for soil, during composting microorganisms such as bacteria and fungi break down complex organic. Compounds into simpler substances and produce carbon dioxide, water, minerals and stabilized organic matter (compost). The process produces heat, which can destroy pathogens (disease causing microorganisms) and weed seeds.

Compositing is the technology of transforming waste organic matter in to Lignoproteins (dark coloured humus) which is a black gold in the Gardner's language and is known as manure. This manure is rich in nutrients and is the key to organic farming [1, 2, 3]. Composting is an ancient technology which finds its roots in nature. It is the nature's way of recycling and managing organic waste back into the soil. This natural biological process is carried out under controlled aerobic conditions (requires oxygen). Traditional method of composting involves making the heaps of wet organic matter as leaves, food waste, and kitchen waste, paper shredded, mixed with grass cuttings, industrial waste as food pulp and paper, sewage sludge, yard and garden waste etc. and waiting till the material gets converted into humus. It is a time-consuming process. In this process, various microorganisms, including bacteria and fungi, break down organic matter into simpler substances. Whereas the modern method of composting involves various steps and the compost is obtained within 2-3weeks. In this method the process is closely monitored [4]. The effectiveness of the composting process is dependent upon the availability of various physical and chemical factors i.e. oxygen, temperature, moisture, pH, material disturbance, organic matter and the size and activity of microbial populations. Based on the requirements water, air, carbon, and nitrogen rich material is added. Worms, fungi, bacteria, are breaking the material. These factors enhance the productivity of humus to a large extent by producing the heat and providing optimum conditions. It was Sir Albert Howard who worked extensively in India on sustainable practices and current composting practices use essentially the same principles that Howard promulgated in his famous book "The Agricultural Testament".

The composting process

Composting of agricultural waste and municipal solid waste has a long history and is commonly employed to recycle organic matter back into the soil to maintain soil fertility. The recent increased interest in composting however has arisen because of the need for environmentally sound waste treatment technologies. Composting is seen as an environmentally acceptable method of waste treatment [5]. It is an aerobic biological process which uses naturally

occurring microorganisms to convert biodegradable organic matter into humus like product. The process destroys pathogens, converts N from unstable ammonia to stable organic forms, reduces the volume of waste and improves the nature of the waste. It also makes waste easier to handle and transport and often allows for higher application rates because of the more stable, slow release, nature of the N in compost [3, 6]. The effectiveness of the composting process is influenced by factors such as temperature, oxygen supply (i.e. aeration) and moisture content.

Kinds of Composting

Composting process is of two types- Aerobic and anaerobic composting.

Aerobic Composting: - Composting is the decomposition of organic wastes in the presence of oxygen (air); products from this process include CO_2, NH_3, water and heat. This can be used to treat any type of organic waste but, effective composting requires the right blend of ingredients and conditions. These include moisture contents of around 60-70% and carbon to nitrogen ratios (C/N) of 30/1. Any significant variation inhibits the degradation process. Generally, wood and paper provide a significant source of carbon while sewage sludge and food waste provide nitrogen. To ensure an adequate supply of oxygen throughout, ventilation of the waste, either forced or passive is essential [7].

Anaerobic Composting

Composting is the decomposition of organic wastes in the absence of O_2, the products being methane (CH_4), CO_2, NH_3 and trace amounts of other gases and organic acids. Anaerobic composting was traditionally used to compost animal manure and human sewage sludge, but recently is has become more common for some municipal solid waste (MSW) and green waste to be treated in this way [8]. Anaerobic composting is decomposition that occurs using microorganisms that no not require oxygen to survive. In an anaerobic system the majority of the chemical energy contained within the starting material is released as methane. The process is characterised by very strong odours and only a small amount of heat is generated meaning decomposition takes much longer and doesn't reach sufficient temperatures to safely kill plant pathogens, weed and seeds. To overcome these limitations external (artificial) heat is normally added. Anaerobic composting was traditionally used to compost animal manure and human sewage sludge, but recently is has become more common for some municipal solid waste (MSW) and green waste to be treated in this way [9].

Stages of Composting

Composting typically consists of four stages namely

1. The Mesophilic Stage or Initial Activation Stage (1-3 days)
2. The Thermophilic Stage (Few days to several months)
3. The Cooling Stage (Few months)
4. The Curing or Aging or Maturing Stage
1.

Primary methods of Composting

a. Indoor: Indoor composting procedures involve storing damp organic matter (i.e. a ratio of green, carbon rich waste and brown, nitrogen rich waste) in compost bins or turners so the materials break down into humus.
b. Windrow composting: - Windrow composting generally refers to the outdoor composting system that strongly relies on mechanical aeration and is the commonest form of open composting system where the composting waste is flipped at intervals throughout the composting process. In windrow, compost is piled in spaced, triangular pointed rows, and aeration occurs by flipping the row into the space preceding it. Windrow composting requires a large area of land and usually taking more time to reach the mature stage. Wind-row composting consists of placing the mixture of raw materials in long narrow piles called wind-rows that are agitated or turned on a regular basis.
c. Aerated static pile (ASP): In aerated static pile composting, organic waste mixed in a large pile. To aerate the pile, layers of loosely piled bulking agents (e.g., wood chips, shredded newspaper) are added so that air can pass from the bottom to the top of the pile. The piles also can be placed over a network of pipes that deliver air into or draw air out of the pile. Air blowers might be activated by a timer or temperature sensors.
d. In Vessel Composting: - In-vessel composting refers to a group of methods that confine the composting materials within a building, container or vessel [10]. In-vessel methods rely on a variety of forced aeration and mechanical turning techniques to accelerate the composting process. Compare to windrow and ASP systems, in-vessel composting is more efficient and less land area is required. Compost production always happens in a very short period of time with the good control of the operational system. In-vessel composting is the most costly system among the rest.
e. Vermicomposting: Red worms in bins feed on food scraps, yard trimmings, and other organic matter to create compost. The worms break down this material into high quality compost called castings. Worm bins are easy to construct and are also available for purchase. One pound of mature worms (approximately 800-1,000 worms) can eat up to half a pound of organic material per day. The bins can be sized to match the volume of food scraps that will be turned into castings. It typically takes three to four months to produce usable castings. The castings can be used as potting soil. The other by product of vermicomposting known as "worm tea" is used as a high-quality liquid fertilizer for houseplants or gardens.

The efficient species of earthworms are *Eisenia foetida*, *Pheretima elongata*, *Eudrilus eugeniae*, *and Perionyx excavatus* [11, 12]. Their worm manure is then used as a nutrient rich organic fertilizer and soil conditioner. It is a cost-effective, time saving, and efficient process of recycling nontoxic animal and agricultural and industrial wastes. Vermicast is rich in nutrients—N, P, K, Ca, Mg, vitamins, enzymes, and growth-promoting substances. Vermicomposting is a rapid, simple, easy-to-control, energy-saving, and cost-effective composting process that can produce a valuable product [6, 7, 8]

Compost Quality

Compost quality is measured by several criteria, including

the following: 1. Moisture Content. 3. Heavy Metal. 5. Stability. 2. Nutrient Content. 4. Particle Size Distribution 6. Pathogen Levels. 7. Product Consistency over Time.

USES of compost

a. Soil Conditioner- In Soil addition of compost leads to addition of balanced nutrients to soil reduces soil erosion as well as improvement of soil's structure, aeration and water retention [13]. Wyoming the soils tend to be clayey or sandy. When organic matter, like compost, is added, the soil structure improves and leads to improved nutrient and moisture storage capacity [14].
b. Kitchen Garden and Lawn Dressing- Compost is excellent for growing quickly maturing crops like vegetables and flowers, and when combined with intensive gardening, can increase production by as much as 3 to 5 times [15].
c. Managing organic waste - Composting organic waste allows for decomposing the organic materials into a more compact form for management [16]. Compost has been used at the household or small farm level for recycling of organic matter and nutrients for thousands of years. Since the late 20th century, more and more large-scale composting facilities were established to manage and recycle organic waste from urban areas.
d. Composting can eliminate most phytopathogens and also inactivates pathogenic viruses [17, 18].
e. Reduces methane emissions from landfills and reduces carbon [19, 20].
f. It enriches the soil, helps retain moisture and eliminates pests and plant diseases.
g. The pH of the soil is altered by the addition of compost. Optimum pH for the cultivation of most fruits, vegetables and the herbaceous ornamental plants are usually between 6.0.and 7.5. If the soil is too alkaline (about pH 7.5), the compost can help you lower it. If the soil is too acid (which is not common in Wyoming), compost can help solve it.

Disadvantages of Chemical Fertilizers

Though chemical fertilizers have proved to be a boon for humanity as they have succeeded in satisfying hunger worldwide, still the excessive use of these fertilizers has certain disadvantages which outweigh their advantages. Some of these disadvantages are

a. Synthetic fertilizers have an adverse effect on the microorganisms inhabiting the soil. The pH of these fertilizers alters the pH of the soil thus affecting the kind of microorganisms that can survive in the changed pH.
b. Excessive use of these chemical fertilizers can cause irreversible damage to the soil structure and composition. These fertilizers are generally water soluble and permeate into the lower layers of the soil along with the groundwater where they interact with the clay forming impermeable layers called hardpan.
c. These synthetic fertilizers make the plants more prone to infections as they are rich in Nitrogen (N). Their use alters the N/P ratio of the soil which leads to more mosaic infections amongst the plants.
d. Chemical fertilizers can cause burns to the roots of plants. Chemical fertilizers do not allow adequate amount of water store in plants. Chemical fertilizers are rich in nitrogen salts and when the nitrogen is absorbed too rapidly in the soil; it dehydrates and dries the plant. Nitrogen fertilizers decompose into nitrates and reach easily to the ground. It is soluble in water so it can remain in groundwater for decades [20, 21, 22].
e. Although chemical fertilizers will help plants grow faster but the plants will not be healthy and strong because plants grown that way do not have sufficient time to mature to develop good root growth. Also, the food from these crops will be less nutritious [23, 24].

Conclusion

Composting is an environmentally friendly method rather than directly dumped into earth and it method is useful to convert organic waste to useful products and that would otherwise have been land filled [25, 26, 27]. Compost has a lot of benefits like: reduce landfill space, reduce surface and groundwater contamination, reduce methane emissions, reduce transportation costs, reduce air pollution from burning waste, provide more flexible overall waste management, enhance recycling of materials and can be carried out with little capital and operating costs [28, 29, 30, 31].

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