

A Review on Composting of Food Waste

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Abstract: Food waste is a global tragedy. The composting process can be conducted in a series of different microorganisms aiming to degrade organic matter. It is a biochemical process which is carried out by diverse groups of different kinds of microorganisms and nematodes. Changes in temperature could be used to know the microbial activity along the entire process and to determine the organic material stability. The characterization of food waste and the available bulking agent before composting is of primary importance. Composting food waste involves the biological decomposition of organic matter into nutrient-rich compost through microbial activity. This process not only diverts organic waste from landfills, where it generates methane, a potent greenhouse gas, but also produces a valuable soil amendment that enhances soil structure, fertility, and moisture retention. Additionally, composting reduces the need for chemical fertilizers, thereby promoting sustainable agricultural practices and preserving ecosystem health. The composting operational conditions and the conditioning of the raw materials have been widely studied, as seen in the scientific literature. However, new technologies have led to increased study on microbial succession and its impact on the quality of the final compost. Food waste composting presents economic advantages by reducing waste disposal costs for municipalities and businesses. It also creates opportunities for community engagement through composting initiatives, fostering environmental awareness and social cohesion. However, challenges such as odor management, regulatory barriers, and public perception need to be addressed to maximize the adoption and effectiveness of food waste composting programs.

Keywords: *Composting food waste, microorganisms, compost, Synthetic food wastes, aerobic composting, enzymes, degradation.*

I. INTRODUCTION

Food Waste Index Report shows the world is wasting over 1 billion meals a day. Not only is this a major development issue, but food waste continues to hurt the global economy and fuel climate change (New UN Environment Programme, 2024). Food waste is a global tragedy.

Composting is a process highly valued in waste management owing to its robustness and the possibility of obtaining a valuable product with soil amendment potential. They observed that HOAS could replace composting food waste as a standard experimental sample formulation for composting trials, which can improve the reproducibility and scientific nature of FW composting experiments. (Jufei Wang et al. 2024). Microbial dynamics

analysis revealed that mature compost addition increased the bacteria related to maturity during the initial stage, and these bacteria were easier to grow again during cooling stage, thus shortened the composting time. (Ya Tang et al. 2022). A method of predicting 10 major results of food waste composting in terms of weight fractions of protein and fat of synthetic food waste made of human and animal foods were developed successfully. Chang, Tin-En. Hsu et al. (2008). Synthetic food wastes made of dog food could be composted successfully in 4 days.

In the process involved two major distinct stages of composting. The peaks of temperature, CO₂ evolution and O₂ utilization rates occurred (I. Chang, J.J. Tsai, K.H. Wu et al. (2006). During aerobic composting of SS, addition of matured compost

enhanced the activities of most functional enzymes like cellulase, peroxidase, arylsulfatase, and urease during thermophilic phase, but reduced the peak temperature, shortened the thermophilic phase. Bacteria were inoculated in the early stage of composting with the addition of the matured compost, which increased the diversity of bacteria in the mesophilic phase. (Chuang Ma et al.,2019).

The Co-application of biochar with NPK increased available soil phosphorus, constituents of cucumber fruit and net income than the co-applied biochar with manure. These findings showed that co-application of biochar and NPK fertilizer can restore degraded soil in the tropics than co-application of biochar with farmyard manure. "Nitrogen, cucumber yield, nutrient. (Samuel Obeng Aporiet al. 2019). This project measured the quantity of food waste (FW) produced by downtown Montreal households and a restaurant. The FW quantity, moisture content and TKN were found to significantly increase from May to August whereas the C/N ratio was found to decrease. (Bijaya K. Adhikari et al. (2008). Optimization of composting conditions at laboratory-scale permitted us to obtain the optimal values of bulking agent particle size: 0– 5 mm and bulking agent: sludge volumetric ratio: 1:1 for both RS and ADS. Under these conditions, the temperature and time required to destroy Salmonella could be reached.

II. METHODOLOGY

The composting process can be conducted in a series of different microorganisms aiming to degrade organic matter. Therefore, the monitoring of these microorganisms in succession is key for effective management of the composting process, rate of biodegradation, and compost quality given that the appearance of some microorganisms reflects the maturity of the compost. The use of compost derived from the organic fraction of municipal waste as a soil conditioner or fertilizer is a sustainable practice for food waste recycling which profits from the nutrients

present in the compost. Compost quality is an important aspect regarding the confidence of compost users. One of the main concerns when using food-derived compost is loading the soil with metals that can result in an increased metal content in the crops (Alejandra Cerda et al.2018). To determine the amount of HFW produced in households in a housing estate, 10 families were selected to collect food waste for 20 weeks. For information on the composition and amount of collected kitchen waste, a form was prepared according to the methodology. Part of the waste was a raw material base for entry into the Naturel Mill composter. Private households represent the largest food-waste sector along the food supply chain. The average HFW value in the monitored group was 100.4 ± 65.7 kg/capita/year. In other households, all family members have lunch out of their homes except weekends. Present composting-related studies have consistently favoured the use of FW feedstocks obtained through random collection methods. Additionally, the FW utilized by Manu et al. (2021) was also collected locally through random collection procedures. Human and animal foods such as steamed rice, wheat meal, soy, fish and meat meals, and lard were mixed to form a synthetic food waste of a desired composition of carbohydrate, protein and fat. Rice and lard were bought from the local grocery store. Experimental results of major process parameters such as the composting time, highest temperature, final pH value, the cumulative carbon dioxide evolution, and percentages of material losses.

Food waste collected from dining halls, hotels, and cafeterias on the Penn State campus was hauled to the compost site. Cow manure from a frees tall barn bedded with sand and mulch hay was obtained from Farm Operations at Penn State. All windrow piles showed leaching problems and odour for the first 15– 20 days due to high moisture content (>60%) and poor physical structure of the compost mixture. The uniformity of a synthetic food waste offers a distinct advantage over restaurant or cafeteria wastes in controlling the variability of substrate characteristics (Clark et al., 1977, Schwab et al., 1994). To control the variability of substrate characteristics, a synthetic food waste made of

homogeneous dog food pellets with a balanced composition of important nutrients for degradation similar to those used in composting. It is a biochemical process which is carried out by diverse groups of different kinds of microorganisms and nematodes. It is a solid-state fermentation process (Kaiser, 1996) which is majorly carried out by aerobic + Though composting is thought to be an oxygen-demanding process which involves the hydrolysis of organic matter into, anaerobic organisms such as Clostridium.

The effectiveness of the composting process is influenced by factors such as temperature, oxygen supply (i.e. aeration), moisture content, pH, C/N ratio, particle size and degree of compaction. Many soil properties have been reported to improve after the application of biochar. These include soil bulk density, hydraulic conductivity, water holding capacity, soil structure, water retention, nutrient retention, soil pH, available phosphorus, potassium, total nitrogen, microbial biomass, calcium, soil porosity, hydraulic conductivity, total organic carbon, cation exchange capacity and soil aggregation.

The increase of the soil pH during the liming process is attributed to the substitution of hydrogen and aluminium iron on the colloidal surface of the soil with the cation oxides, thereby decreasing the exchangeable acidity ($H^+ + Al^{3+}$) in the soil environment. It also provided valuable information regarding the physicochemical evolution of the composting process, most effective BW for rapid composting and finally production of quality compost from OFMSW.

The temperature is one of the most ominous factors used to monitoring the progress of composting process transformation. Changes in temperature could be used to know the microbial activity along the entire process and to determine the organic material stability. The characterization of food waste and the available bulking agent before composting is of primary importance, to balance the recipe in terms of moisture content for aeration, pH for a proper

microbial environment, and carbon and nitrogen for proper microbial development. Aeration is facilitated when the compost mixture offers a 30% free air space (FAS), which may vary depending on the substrates and the composting systems. This value, FAS, is calculated based on the porosity of the wet mixture occupied by air.

The water content of sewage sludge is usually too high for composting even if a dewatering treatment is applied to this material. In a majority of cases the addition of a bulking agent is necessary. A bulking agent is a material that provides FAS and regulates the water content of the waste to be composted. examine the influence of the bulking agent particle size and bulking agent: sludge volumetric ratio on the composting process of two different types of sewage sludge: dewatered raw sludge (RS) and dewatered anaerobically digested sludge (ADS). The full composite factorial experimental design technique is applied to plan the experiments necessary to study the influence of the mentioned factors on sludge composting process and to determine the relationship among them. The variable monitored is the temperature profile reached in a composting experiment. As stated above, the combination of the two parameters (temperature and time) will determine the degree of sludge disinfection. By transforming organic waste into a valuable resource, composting contributes to sustainable development goals, including waste reduction, climate change mitigation, and soil health improvement. Embracing composting as a mainstream practice necessitates collaborative efforts among policymakers, businesses, communities, and individuals to realize its full potential in building a more resilient and sustainable future. Food waste composting is a sustainable practice that converts organic waste into nutrient-rich compost, thereby reducing landfill burdens and contributing to soil health.

III. CONCLUSION

1. The composting operational conditions and the conditioning of the raw materials have been widely studied, as seen in the scientific literature. However,

new technologies have led to increased study on microbial succession and its impact on the quality of the final compost.

2. The home composting is a suitable treatment option for organic wastes such as leftovers of raw fruit and vegetables (LRFV), from the technical and environmental point of view. The physicochemical properties of the final compost obtained were in the range of high quality and stable compost. Although temperatures did not reach the thermophilic level, hygienisation occurred.

3. Compost addition enhanced the degradation of organic matter and shortened the composting period. Microbial dynamics analysis revealed that mature compost addition increased the bacteria related to maturity during the initial stage, and these bacteria were easier to grow again during cooling stage, thus shortening the composting time.

4. The highest temperature, final and lowest pH values, cumulative carbon dioxide evolution and percentages of material losses (in terms of weight fractions of protein and fat of synthetic food waste made of human and animal foods) were developed successfully.

5. The optimum mixture for in-vessel composting (50% food waste, 40% manure, and 10% bulking agents) was tested for two forms of windrow composting. The achieved temperatures were higher than the in-vessel system and retained for a longer time interval. The achieved temperatures were higher than the in-vessel system and retained for a longer time interval.

6. In most cases except those of 32% of seeding, the process involved two major distinct stages of composting. Made of dog food could be composted successfully in 4 days. All products at the end of a 4-day composting period passed all maturity tests.

7. They stated that the use of additives, such as jaggery and polyethylene glycol reduces the composting process time as well as produces superior quality compost. However, according to their reports,

the additives currently used are not cost effective.

8. Bacteria were inoculated in the early stage of composting with the addition of the matured compost, which increased the diversity of bacteria in the mesophilic phase. During the mesophilic phase, but reduced the peak temperature, shortened the thermophilic phase, and inhibited the degradation of organic matter.

9. The combined application of biochar with farmyard manure and NPK increased soil quality indicators such as soil pH, total organic carbon, soil available phosphorus, and total nitrogen than the solely applied manure and NPK.

10. The positive effect of matured compost as a bulking and inoculating agent on newly manufactured cattle manure compost was demonstrated. Because the total volume of compost material was different between the CR compost and the CRM1 and CRM2 composts, even though the height of their compost piles was adjusted to be the same, it may not be appropriate necessarily to compare them directly.

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