Research Journal of Environmental Sciences

ISSN 1819-3412

Academic
Journals Inc.

www.academicjournals.com

OPEN ACCESS Research Journal of Environmental Sciences

ISSN 1819-3412
DOI: 10.3923/rjes.2018.229.233

Research Article
Physical Variation During Predigestion of Selected Organic Waste Before Vermicomposting

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Abstract

Background and Objective: Production of large quantities organic waste by domestic and daily life activities need to be reutilized in an effective way. Composting and vermicomposting offers a best means for this bioconversion of organic wastes into valuable organic manure. The present study was an effort to develop small scale vermicomposting of locally available organic wastes in mud pots and assess the predigestion changes occurring in them. **Materials and Methods:** The experiment was arranged in four treatments with different combinations of organic wastes and subjected to predecomposition. The variation in temperature was recorded and pH and electrical conductivity were observed. The temperature of the digesting materials were compared with atmospheric temperature. **Results:** The variation in temperature indicated the activity occurring in decomposition process. The pH and moisture content also varied during these period. There was considerable variation in observed parameters during the predigestion period. **Conclusion:** The predecomposing of organic wastes in anaerobic condition help the breakdown of organic matter and reducing the bulk. This help further vermicomposting to yield a quality organic manure.

Key words: Organic waste, composting, vermicomposting, temperature, ph, electrical conductivity

Citation: Mohammed Arshad Siddiqqui and Hiranmai Yadav Rameshwar, 2018. Physical variation during predigestion of selected organic waste before vermicomposting. Res. J. Environ. Sci., 12: 229-233.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The increasing population and urbanization is forcing the world to face the problem of solid waste management that is considered as biggest environmental challenges. A sustainable approach is needed to overcome the pollution caused by the solid waste by converting it into useful products by composting and vermicomposting. The organic solid waste treatment by composting is a natural process that is widely practiced for waste management. Vermicomposting involves earthworms for the process of degradation of biodegradable materials. The resultant product is rich in nutrients, enzymes and plant growth promoting substances[1].

Vermicomposting is one of the biotechnological process where earthworm convert the waste into a quality product containing macro and micro nutrients. These nutrients have significant influence on the growth and yield of plant, fertility and microorganism of soil[2]. Vermicomposts and composts are prepared using organic constituents which are piled and moistened and permitted to undergo a thermophilic decomposition resulting in an end product rich in humus and microbial populations. They also contain plant available form of nutrients and growth hormones. The vermicomposts also provides protection against various plant diseases[3]. In a bioremediation study using vermitechnology, there was considerable improvement in the soil quality which establishes the importance of vermicomposts application for soil properties. This method of re-clamation was found to be sustainable[4].

To introduce earthworms the waste material should be in a form to be used by them. This could be achieved by degrading them into smaller particles making them easy for ingestion. As the decomposition progresses, the organic intermediates like various aliphatic acids, amino acids and phenols will be converted to water insoluble high molecular weight organic compounds. These are utilized by micro-organisms and finally the recalcitrant compounds are converted into humus like product. Therefore, organic-carbon to nitrogen ratio declines with the duration of composting process[5].

Decomposition is a natural process that aids in reduction of waste by action of a variety of living organisms and influenced by different bio-geochemical processes. Now-a-days the increased population and enhanced utilization of different materials for daily life have increased waste materials. These are getting dumped since the quantity of wastes produced is above the ability of natural process of decomposition. The vermicomposting or utilization of earthworm for degradation of organic wastes like agricultural and domestic wastes are practiced by farmers from time immemorial.

The present study was conducted with an objective to assess the predecomposition phase of composting and the temperature variation in it in addition to pH and electrical conductivity.

MATERIALS AND METHODS

Study area: Gandhinagar district of Gujarat state lies between 72.3'-73.7' E (longitude) to 23.0'-23.6' N (latitude) with a geographical area[6] of 2,163.48 km^2.

Composting system: The study was conducted with organic waste materials in different ratios (Table 1).

The vegetable wastes used in this experiment contained onion peel, discarded brinjal, green chillies, coriander, cabbage, tomato and drumstick. The food waste was with cooked rice and wheat, vegetables, legumes and spices. The municipal solid waste (MSW) included different domestic wastes like paper clippings, cloth, hard boards, leaves and sticks, disposable cups etc. These wastes were collected from local vegetable and fruit market, university cafeteria and disposal site.

Duration of the study: The materials were shredded and weighed in specific ratios and transferred to mud pots of 7 kg capacity. They were layered and allowed to remain in anaerobic condition for 30 days during March-April, 2017.

Analyses: During this period, the temperature of digesting materials in the pot was monitored using soil thermometer considering the central region and atmospheric temperature was also noted for comparison in difference of temperature. The pH and electrical conductivity were assessed by pH meter and conductivity meter.

Table 1: Treatment details of the compost preparation

Treatments	Composition details
T_1	Vegetable waste+fruit waste+FYM
T_2	Vegetable waste+fruit waste+food waste+FYM
T_3	Vegetable waste+fruit waste+MSW+FYM
T_4	Vegetable waste+fruit waste+food waste+MSW+FYM

RESULTS AND DISCUSSION

The organic wastes like vegetable waste, fruit waste, food waste, MSW that are dumped in large quantity are difficult for collection, transport, storage and processing. This study gives an outline about the utilization and conversion of these daily wastes generated by market and domestic activities into valuable manure. This will help to reduce the dumping of wastes that creates water, air and soil pollution due to natural processes of decomposition. To make the organic wastes suitable for vermicomposting and further stabilization it need to undergo a process of pre-composting. The bulk of the wastes were observed to get reduced during the process of precomposting and changes in texture and quality of wastes were also observed. The volume of wastes in all treatments were reduced to 80% by the end of pre-composting period. This could further be confirmed by the variation in height of the organic matter subjected to composting. There was reduction of height of the organic waste due to changes occurring by decomposition activity.

The temperature variation (Fig. 1) was significant in different treatments (T_1-T_4) during the precomposting period. Temperature variation indicates the biochemical reactions occurring in the composting materials.

The pH and electrical conductivity (Fig. 2) are factors influencing the decomposition reactions and indicates the variability occurring in the composting material due to the activities of microbes. The variations in chemical components of the decomposing materials also indicates the mineralization processes occurring in the organic materials.

The significance of predigesting of organic wastes before vermicomposting is earlier studied by Nair *et al.*[7]. This predigestion period of thermal composting enhances the waste stabilization and pathogen removal for vermicompost production. It helps in stabilization of pH, moisture content and further mass reduction. This process helps in vermicomposting process by providing easy utilization by earthworms and conversion into a stabilized organic matter with improved nutrients. The thermophilic stage of compost lasts for a longer duration based on organic matter content

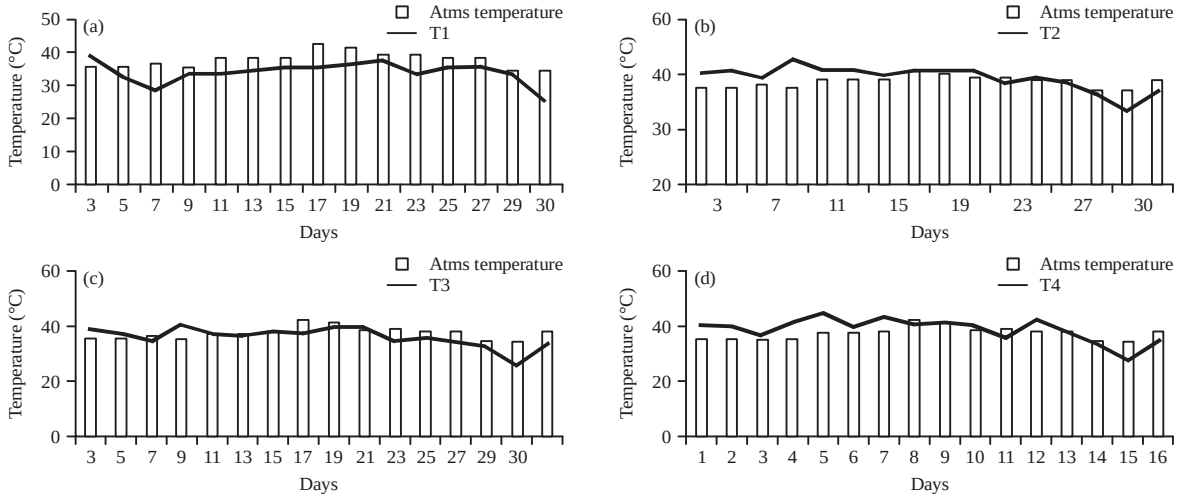

Fig. 1(a-d): Temperature of predigesting organic wastes in different treatments (°C)

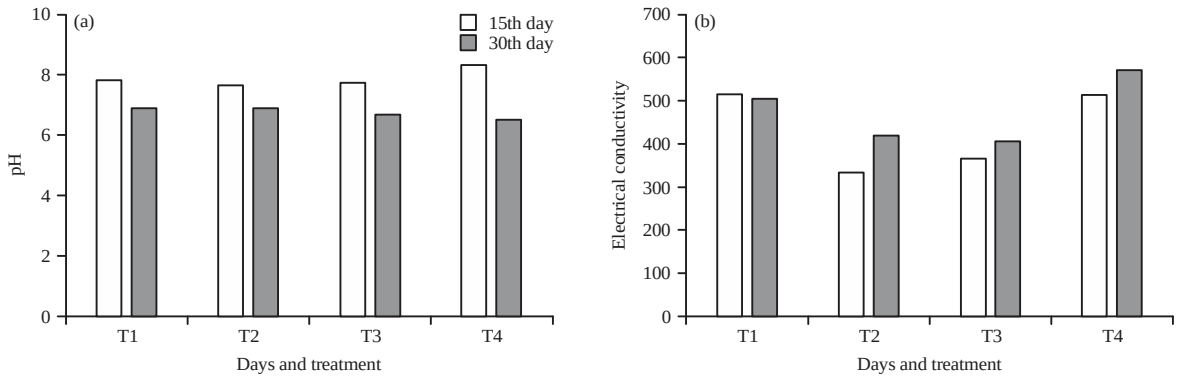

Fig. 2: pH and electrical conductivity of predigesting organic wastes

and organic nitrogen in the waste materials under process[8]. Reduction in pH during vermicomposting could be due to the bioconversion of materials into various intermediate products containing organic acids[9] and mineralization of nitrogen and phosphorus into nitrites/nitrates and orthophosphates and production of humic and fulvic acids. Further microbial activity during degradation also produces CO_2 and organic acids which also brings about changes in pH[10]. Several earlier workers have also observed increase in electrical conductivity during end of composting process which is related to the changes in organic matter and mineral salts[8]. A value of 3 dsm^{-1} can be considered as threshold value for electrical conductivity[11]. As the organic matter is ingested by earthworm they get fragmented and homogenized in earthworm gut which increases the area for microbial activity. Gut microbes produce enzymes for degradation. This combined activity of worms and microbes brings about changes in organic carbon and nitrogen[12].

Temperature of composting materials plays a significant role in degradation as it influences the microbial population and the state of organic materials conversion in the compost. High thermophilic temperatures in composting process of large amounts of wastes help in conversion of various carbon components. Reduction in temperature after this stage leaves a sufficient quantity of carbon that can be readily degradable by microbial activity[13]. Newspapers did not increase the compost temperature to 45°C but the presence of active microbial community facilitates the composting process and reduces the particle size[14].

Food wastes could be composted in smaller stacks as the time required for turning of compost shortens[15]. The temperature change in composting process is a typical pattern observed while blending onion peel in composting[16]. The co vermicomposting was found to be effective in terms of reduction of wastes and potential application in sustainable agriculture[17]. Vermicomposting provide means of organic waste recycling by producing a humified material and promotes carbon sequestration when applied to soil. Increased population and urbanization is reducing the farming land. In addition the available land is getting reduced in soil organic matter due to intensive crop practices wherein the utilization of organic fertilisers are promising technology for promoting healthy and sustainable agriculture[18]. Composting of kitchen waste is an effective method for reducing its dumping to landfill and conserve the environment.

CONCLUSION

Scarcity of conventional organic manures have made to look for alternatives by recycling different organic wastes that can help in abatement of pollution. The reuse of organic wastes in agriculture improves soil quality and subsequent crop production. For using in agriculture different organic materials need to undergo a composting process for adequate period thus improving its quality in terms of nutrient matter. Traditional composting systems are not completely giving the value added product so the utilization of earthworms were started. This simple and efficient technology is now widely used for recycling of wastes effectively into manure. There is a need for a technology that could be used for sustainable production without affecting the soil quality. The soil organic matter need to be maintained and produce good quality foods.

SIGNIFICANCE STATEMENT

This study found that the conversion of solid waste in to valuable product through composting and vermicomposting can be beneficial for proper management of solid waste. This could be accomplished through predigestion process and this study helps the researcher to uncover the critical areas of the physical variation that is important to produce quality manure from mixed wastes. Thus a method which helps in proper management of solid waste may be arrived at following the degradation methods adopted from nature.

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