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A CASE STUDYON COMPOSTING AND VERMICOMPOSTING AT DRY RESOURCE CENTRE, SEETHAMMADHARA, VISAKHAPATNAM AND ASSESSMENT OF COMPOST PROPERTIES

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ABSTRACT
Continued population growth and as well as changing consumption patterns have led to an explosion in the amount of waste produced, especially in cities. To feed the world, we also need to increase agricultural production while limiting our impact on the environment. Part of the solution could be to recycle the organic fraction of municipal solid waste as a resource for agriculture near cities with techniques such as vermicomposting, which uses earthworms to recycle organic waste into nutrient-rich vermicompost. The objective of the present work is a detailed study on composting and Vermicomposting. It also includes Aerobic composting of   and Coconut shells. Case study was done at Dry Resource Centre, GVMC, Seethammadhara. Composting has proved an effective way for municipalities to reduce both space and methane gas in landfills. The time taken for the completion of the Vermicompost is about 60-90 days and Aerobic composting is about 30-40 days.
The physico-chemical parameters such as moisture content, pH, electrical conductivity, bulk density, C/N ratio were determined, for vermin compost, compost from MSW and coconut shell compost.

Keywords:
Composting, Vermi-composting, Compost.

1. Introduction

Composting is the natural biological process in which degradable part of waste is transformed to a stable material with excellent characteristics for application on soils. Thus, it requires a pretreatment such as removal of big fractions and other contaminants that could affect the composting process and final quality of compost. Such type of technique must be effective efficient and less costly. Agricultural application of composted Municipal Solid Waste, as nutrient source for plant and as soil conditioner ,is the most cost effective option of MSW management. MSW composting is the process by which the organic, biodegradable portion of MSW is microbiologically degraded under aerobic conditions. During the process of degradation, bacteria are used to decompose and breakdown the organic matter into water and carbon dioxide, which produces large amounts of heat and water vapor in the process. Given sufficient oxygen and optimum temperatures, the composting process achieves a high degree of volume reduction and also generates a stable end product called compost that can be used for mulching, soil amendment, and soil enhancement. As a form of solid waste management, MSW composting reduces the amount of waste that would otherwise end up in landfills. Properly managing dry and wet waste is important for both environmental and economic reasons, as well as for the overall well-being of communities. Composting is a preferred material recovery technique.

2. Objectives of the Study

The objectives of the present study are as follows:
1.To do case study of composting and Vermicomposting processes of organic waste which is compostable at Dry Resource Centre, GVMC, Seethammadhara.
2.To determine physico-chemical characteristics of windrow compost, coconut shell compost and vermi compost for the following characteristics- 1)pH, 2)electrical conductivity, 3)moisturecontent, 4)bulkdensity, 5)C/Nratio, 6)colour,7)textureand 8)odour.
3.To understand the characteristics of vermicompost, aerobic compost and coconut shell compost and understand their nutrient content for agricultural application.

3. Methodology

Windrow Composting

Windrow composting is a method of composting organic materials in long, narrow piles called windrows. This technique is commonly used in large-scale composting operations, such as those found in agricultural settings, municipal composting facilities, or industrial composting sites.
Materials required: Organic materials of municipal solid waste, Base Material, Water Source, Covering Material, Screening Equipment, Compost testing equipment

Procedure:

Preparation: Organic materials such as yard waste, agricultural residues, food scraps, or biosolids are collected and brought to the composting site. These materials are often shredded or chopped into smaller pieces to accelerate decomposition.

Fig3.1 Organic Waste

Formation of Windrows: The prepared organic materials are arranged in long, narrow piles called windrows. Windrows are typically several feet wide and tall and can vary in length depending on the volume of materials being composted. The windrows are usually placed on a suitable base such as concrete ground.

Fig3.2 Windrows placed on concrete ground

Aeration: Proper aeration is done for the composting process to occur efficiently.

Moisture Management: Maintaining the right moisture level is crucial for composting. Windrows are covered with a tarp or other material to prevent excessive moisture loss or saturation from rain. Monitoring and adjusting moisture levels as needed help create an optimal environment for microbial activity.

Fig3.3 Maintaining the moisture level

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Fig3.4 Set up covered with Tarp

Temperature Monitoring: Composting generates heat as microorganisms breakdown organic matter. The internal temperature in the windrows is monitored to ensure that the compost reaches and maintains temperatures high enough to kill pathogens and weed seeds. Thermometers are often inserted into the windrows to monitor temperature levels.

Maturation: Depending on the materials used and environmental conditions, windrow composting can take (4-6) weeks to complete. During this time, the compost undergoes various stages of decomposition until it matures into a stable, nutrient-rich product.

Curing and Screening: Once the composting process is complete, the finished compost is made to undergo a curing period to stabilize further and reduce the risk of pathogens. It is also screened to remove large particles, resulting in a more uniform product suitable for various applications such as soil amendment or landscaping.

Fig3.5 Screening equipment

Windrow composting is favored for its scalability and ability to handle large volumes of organic waste efficiently. However, proper management and monitoring are essential to ensure optimal composting conditions and produce high-quality compost.

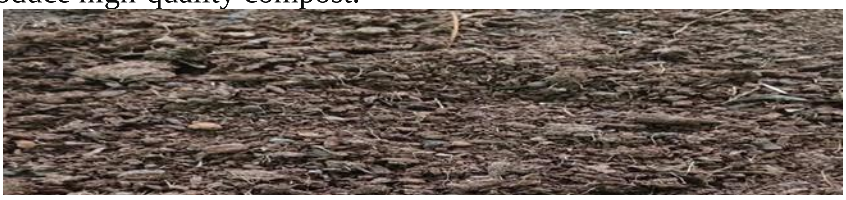

Fig3.6 Matured Windrow compost

Vermicomposting

Vermicomposting is the scientific method of making compost, by using earthworms. They are commonly found living in soil, feeding on biomass and excreting it in a digested form. This process is mainly required to add nutrients to the soil. Compost is a **n**atural fertilizer that allows an easy flow of water to the growing plants. The earthworms are mainly used in this process as they eat the organic matter and produce castings through their digestive systems.

Materials Required: Water, Cowdung, Thatch Roof, Soil, Gunnybags, Earthworms,

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Biodegradable municipal solid wastes.

Procedure:
Step1
Compost is prepared using a concrete tank. Vermicomposting is done under thatched roof to protect the worms against sun and rain.

Figure3.7 Concrete Tank

Step2
First a layer of dry coconut waste is applied on to the pit. This will be the hiding place for the worms whenever the ambient temperature increases. Now well composted Cow Dung Manure is added on to the pit upto one foot and then a layer of dry leaves are added. Again, Cow Dung Manure is added and the pit is filled. Dried cattle dung is used, Wet dung is usually avoided in vermicomposting process as they generate too much heat during decomposition.

Figure3.8 Cattle Dung

Step3
Now the Cow Dung manure will be hot and it has to be cooled down. Hence ,water is sprinkled everyday at least for 10 days till the temperature comes down.

Figure3.9 Sprinkling of water

Step4
Selected earthworms are placed uniformly over the material that has to be composted. There is no need to put the earthworms inside, as they move inside on their own. Roughly for one-meter length, one-meter breadth and 0.5-meter height of the Vermi bed, 1 kg of worm (1000Nos.) are needed. The best worms to use in a vermicomposting operation are red wigglers. Worms need moisture to live and breathe; bedding is made wet before the worms are added.

Figure3.10 Earthworms are introduced

Step5
60%moisture is maintained throughout the composting process. Hence, daily watering of the Vermi bed is not done but water is sprinkled over the bed whenever it is necessary. Compost mixture is covered with gunny bags.

Step6

Harvesting of the castings formed on the top layer are done periodically i.e., once in a week. Watering is stopped before the harvesting of vermicompost. The casting are scooped out with hand and placed as heap in a shady place.

The Vermicompost is produced after 3-5months. After the vermicompost production, the earthworm present in the bed were harvested. Simple trapping method is used wherein small, fresh cowdung balls are made and inserted inside the bed in five or six places. After 24hours, the cowdung balls were removed. The balls with the worms were put in a bucket of water to separate the worms. The collected worms are used in next batch of composting. After screening to remove undecomposed materials and worms, the final product is obtained.

Step8

The harvested vermicompost is stored in cool, dark place with a minimum 40% moisture. It is not exposed to sunlight as this will lead to loss of moisture and nutrient content.

Figure3.11 Matured Vermi compost

Coconut shell coir compost

Coconut fiber is extracted from the outer shell of a coconut. It is also called coirfiber or coco fiber. It is the natural fiber of the coconut husk where it is a thick and coarse but durable fiber. There are two types of coconut fibers, brown fiber extracted from matured coconuts and white fibers extracted from immature coconuts. Brown fibers are thick, strong and have high abrasion resistance. White fibers are smooth and finer, but .Both brown and white coir consist of fibers ranging in length from 4-12 in (10-30 cm). Those that are at least 8 in (20 cm) long are called bristle fiber. Shorter fibers, which are also finer in texture, are called mattress fiber. Cocopeat is commonly used as a growing medium in horticulture and gardening due to its water retention and aeration properties.

Machine used: Shedder Machine

Figure3.12 Shredder Machine

Procedure:

Step1

The coconut waste is collected from residential places.

Figure3.13 Coconut Waste

Step2

Coconut waste is typically processed using a shredding machine that breaks down the tough coconut husk into smaller pieces.

Figure3.14 Processed through Shredder Machine

Step3
Shredding helps in reducing the volume of waste and makes it easier to handle for subsequent processing steps.

Step4
Wet Coir pit is then sun-dried in concrete yards for 2-3days to reduce the moisture content to the right value so as to achieve the required compaction

Step5
Formation of Windrows: The prepared materials are arranged in long, narrow piles called windrows. Windrows are typically several feet wide and tall and can vary in length depending on the volume of materials being composted. The windrows are usually placed on a suitable base such as concrete ground.

Figure3.15 Formation of Windrows

Step6
Maturation: Windrow composting can take (4-6) weeks to complete. During this time, the compost undergoes various stages of decomposition until it matures into coconut peat.

Step7
The cocopeat that remains once the fibers have been removed is typically sun-dried and compressed into blocks.

Figure3.16CoconutPeat

Determination of physical and chemical properties of composts

S.no.	Property	Method / instrument	Lab at which analysis was done

1.	Colour	Observation	Environmental Engineering laboratory A.U. College of Engineering
2.	pH	pH meter/ Universal indicator solution used for monitoring extract	Environmental Engineering laboratory A.U. College of Engineering
3.	Moisture content	HOT AIR OVEN	Environmental Engineering laboratory A.U. College of Engineering
4.	Electrical conductivity	Conductivity meter used for monitoring extract	Environmental engineering laboratory A.U. College of Engineering
5.	Bulk density	Measuring jar, weighing balance	Environmental Engineering laboratory A.U. College of Engineering
6.	Odour	Observation	Environmental Engineering laboratory A.U. College of Engineering
7.	C/N RATIO	1)Volumetric method (WalkleyandBlack,1934) for carbon 2) IS 14684 for Nitrogen	SV ENVIRO LABS

4. Results and Discussion

The pH is a parameter that greatly affects the composting process. Compost microorganisms operate best under neutral to acidic conditions, with pH's in the range of 5.5 to 8. During the initial stages of decomposition, organic acids are formed. The acidic conditions are favorable for growth of fungi and breakdown of lignin and cellulose. As composting proceeds, the organic acids become neutralized, and mature compost generally has a pH between 6 and 8.

Table4.1Variation in pH of different composts

S. No	Sample Name	pH
1	Vermicompost	6.8
2	Aerobiccompost	6.5
3	Coconutshell compost	6

Colour,Texture and Odour:The mature compost has physical characteristics such as blackish brown colour and smells close to the smell of earth. This is because the material it contains already resembles soil material. Blackish brown colour formed by the influence of stable organic matter. So the mature compost is blackish brown in color, smells like soil and has a crumbly texture.

Table4.2Colour,Odour,Texture of composts

S.No	Sample	Colour	Odour	Texture
1	Vermi compost	Blackish brown	Earthy	Crumbly
2	Aerobic compost	Blackish Brown	Earthy	Crumbly
3	Coconut shell compost	Blackish Brown	Earthy	Crumbly

Bulk Density

The bulk density of compost ranges from 150 to 950 kilogram per cubic meter.

Table4.3Variationinbulkdensityofdifferentcomposts

S.No	Sample Name	Density(kg/m^3)
1	Vermicompost	1008.91

2	Aerobic compost	1059.3
3	Coconut shell compost	134.52

Electrical conductivity:

Electrical conductivity (EC) reflects the level of salinity in a compost product. The electrical conductivity value changes during composting. The initial value of the electrical conductivity increases and on the mature of compost the value of EC decreases and remains constant. Electrical conductivity of compost ranges from about 0.5 to 5 milli siemens per centimeter (mS/cm).

Table4.4Variationinelectricalconductivityofdifferentcomposts

S. No	Sample Name	Electrical Conductivity(mS/cm)
1	Vermi compost	0.506
2	Aerobic compost	0.557
3	Coconut shell compost	2.07

Moisture Content

The optimal moisture content for compost is 45%to 60%. If the moisture content exceeds 65%, anaerobic conditions develop. The aerobic organisms die due to lack of oxygen, and anaerobic organisms prevail. If the moisture content is below 40%, fungi tend to be the dominate organisms. The organic matter will not fully decompose and good finished compost will not be produced. If the moisture content is less than 15%, all biological activity ceases. For four months dried compost sample moisture content typically ranges between 5-15%.

Table4.5Variation in moisture content of different composts

S. No	Sample Name	Moisture Content (%)
1	Vermicompost	2.6
2	Aerobic compost	2.37
3	Coconut shell compost	18.92

Note: Four months dried Compost sample.

C/N ratio

This is the ratio of total carbon (C) to total nitrogen (N) in the sample. C:N ratio may be used as an indicator of compost stability and N availability. The recommended carbon-to- nitrogen (C/N) ratio for compost is 14.5:1 indicating that the compost is relatively high in nitrogen content.

Table4.8 Variation in C/N ratio of different composts

S. No	Sample Name	C/N ratio
1	Vermicompost	12.6:1
2	Aerobic compost	10.6:1
3	Coconut Shell compost	15.5:1

5. Conclusions

The pH value obtained for Vermi compost is 6.8, Aerobic compost is 6.5 and for Coconut shell compost is 6. Hence the composts are considered as mature, stabilized organic material due to its pH's falling within the range of 6 and 8.

Normal range for Bulk Density of compost is 150 to950kg/m^3.A bulk density of 1008.91 kg/m^{3}for vermicomposting and 1059.3 kg/m^{3}for aerobic composting is relatively high. This might suggest that the composts are quite compacted, possibly due to excess moisture or inadequate aeration during the composting process. A bulk density of 134.52 kg/m^3 for coconut shell compost suggests a lightweight and porous material.

EC for Vermicompost .506mS/cm, for aerobic compost is 0.557mS/cm and for coconut shell Compost is 2.07mS/cm. As electrical conductivity (EC) range between 0.5to5mS/cm for compost samples is

generally considered acceptable. This range indicates a moderate to high level of nutrient content in the compost samples.
A moisture content of 2.6% in a four-month dried vermicompost sample and 2.37% for aerobic compost sample indicates a low moisture level. This suggests that the vermicompost has been adequately dried and is likely stable for storage. Moisture content of18.92%in a four-month dried coconut shell compost sample is relatively high. This indicates that the compost may not have been thoroughly dried during the specified period. To enhance the stability and quality of the compost, it is advisable to further dry it to achieve a lower moisture content, typically in the range of 5-15%.
A carbon-to-nitrogen (C/N) ratio for vermicompost is 12.6:1, for aerobic compost is10.6:1. In both cases, the C/N ratio is nearness to the optimum value of 14.5:1 indicating they are relatively high in nitrogen content. Adjustments may be needed to balance the carbon and nitrogen ratios closer to the optimum for better nutrient retention and overall compost quality. The C/N ratio for coconut shell compost is 15:1, it's very close to the optimum value of 14.5:1. This suggests that coconut shell compost is well-balanced in terms of carbon and nitrogen content, making it suitable for effective decomposition and nutrient retention. Overall, a C/N ratio of 15:1 indicates that coconut shell compost is likely to promote healthy microbial activity and nutrient cycling, resulting in high-quality compost for soil amendment and plant growth.

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