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VERMICOMPOSTING PRODUCTION, ANALYSIS, AND POTENTIAL AGRICULTURAL APPLICATIONS

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Abstract

Large-scale solid waste creation is an eco-tech concern. Population expansion, industrialisation, and a shift in lifestyle are making solid waste management a global challenge. Vermicomposting is a novel eco-technology that turns trash into biodegradable material, including food scraps. This strategy may be eco-friendly for trash disposal. This granular, stabilized humus-like product restores organic matter to agricultural soils. Vermicomposting technology uses non-toxic, organic industrial waste. Vermicomposting technology is utilized for industrial waste and sludge management and land restoration. The process's efficacy depends on the source material, pH, temperature, moisture, aeration, vermicomposting system, and earthworm species. The assessment discusses new technology's industry benefits.

Keywords-composting, mineralization, fragmentation, detoxification, urbanization.

Introduction

Vermicomposting transforms organic wastes into humus-like vermicompost using earthworms. Some earthworm species may eat human, animal, and agricultural wastes. Earthworms sustain aerobic conditions in vermicomposting by eating homogeneous organic waste and excreta. Earthworms are involved physically and biologically. The process includes fragmentation, turnover, and aeration. Biochemical activity includes enzymatic digestion, nitrogen enrichment, and molecule transport. Microbial activity changes waste products containing plant nutrients including nitrogen, potassium, phosphorus, and calcium into chemical forms that are more soluble and accessible to plants. Proteases, lipases, amylases, cellulases, and chitinases in earthworms' digestive tracts break down cellulose and proteinaceous substances in organic waste. Earthworms and the microorganisms they eat for decomposition are mutually beneficial. Vermicompost helps regulate solid waste pollution caused by population increase, industry, urbanization, and intensive farming. Vermicomposting may be done at any scale, from household to community or city-sized. The following sections discuss earthworms' rubbish breakdown.

- Waste material ingestion is also a factor.
- The earthworms' saliva softens the organic waste particles in their mouths.
- Softening and neutralization of organic waste and passing it on to the gizzard for further action in the area of the oesophageal body of the worm.
- The muscular gizzard grinds waste into fine particles.
- Proteolytic enzymes in the stomach break down organic waste.
- Enzymes released in the colon break down pulped waste into its component parts, and the digested material is subsequently absorbed by the intestinal epithelium, where it is digested further.
- Undigested food from worm castings is excreted.

Factors that affect the vermicomposting process include both natural and man-made. The following are a few of these elements:

A. Abiotic factors

The most important abiotic factors which affect vermicomposting process include moisture content, pH,temperature, aeration, feed quality, light, C:N ratio etc.

A1. Moisture content

Adequate moisture content is one of the mostimportant factors necessary for the working ofearthworms and microorganisms in vermicompostingsystem. Earthworms breathe through their skin;therefore the system must have adequate moisturecontent. The ideal moisture range in vermicomposting or vermi culture process is 60-80%, yet physical and chemical differences in feed stocks may cause slight variations. Researches have reportedthat even a 5% difference in moisture contentsignificantly affect the clitellum development in Eisenia fetida worm species. Water also acts as amedium for different chemical reactions and transport of nutrients during the process.

A2.pH

Another critical factor in the vermicomposting process is the pH. In order for earthworms and microbes to thrive, the pH should be between 5.5 and 8.5. Neutral or near-neutral pH is ideal. The feed substrate's pH fluctuates significantly during vermicomposting. Vermicomposting of feed substrates often begins with a low pH level. In the beginning, carbon dioxide and volatile fatty acids are formed. It begins to increase in pH when CO2 and volatile fatty acids are used and the process proceeds.

A3. Temperature

During vermicomposting, earthworms like 12 º –28º C. Temperature affects worm activity. In winter, the system should be kept above 10º C, and in summer, below 35ºC. As vermicomposting temperatures drop, earthworms can't reproduce and their metabolic activity drops. Earthworms don't eat at low temperatures. Above 35o C, earthworm metabolism, reproduction, and mortality diminish. Species' temperature preferences differ.

A4. Aeration

Earthworms require oxygen for vermicomposting. Microbial, earthworm, and substrate temperature affect soil oxygen. Excessive moisture in a vermicomposting system may affect worms' oxygen intake. Fatty, greasy substrates limit oxygen supply. Before adding fatty or oily waste to the feedstock, pre-compost it. Mechanical aeration or manual rotation can increase vermicomposting aeration.

A5. Feed quality

Earthworms need a good meal for vermicomposting. Earthworms devour many organic materials. Earthworms' daily food intake depends on particle size, decomposition state, C:N ratio, and salt content. Small-particle feed waste speeds up vermicomposting. Due of the small particle size, aeration and worm access are available. Worms eat 100-300 mg/g body weight/day. Earthworms eat macrofauna, organic debris, and microorganisms. Surface earthworms are selective eaters, whereas deeper earthworms eat the whole soil. Worms hate salt. Dietary salt should be 0.5%. No non-biodegradable or toxic components should be in earthworm diet (e.g. inert materials, plastics, metal objects, detergents, medications, etc.).

A6. Light

Earthworms are naturally photophobic. In this sense, light should be avoided at all costs. All forms of paralysis and death are possible for earthworms exposed to sunlight for a short period of time. To avoid the light, they employ light-sensitive skin cells clustered at the front of their bodies.

A7. C:N ratio

Earthworm development and reproduction may be regulated by feed C:N ratio. Higher C:N in meal accelerates worm growth and reproduction. C:N imbalance hinders waste breakdown. For plants to absorb mineral nitrogen, C:N must be 25–20:1. With earthworms, the C:N ratio in littered soil is less than 25:1. Vermicomposting requires bacteria, which need carbon and nitrogen to make proteins. Effective vermicomposting requires a high C:N ratio. If the organic feed material is nitrogen-deficient and the C:N ratio is high, microbial activity declines.

B Biotic factors

Various biotic factors which affect vermicomposting process include earthworms stocking density, Microorganisms, enzymes etc.

B1. Earthworms stocking density

Vermicomposting relies significantly on earthworms, which alter microbial populations and nutrient dynamics. Vermicomposting earthworm density affects respiration, reproduction, feeding, and burrowing. Eight earthworms need 43.61 g of pig manure for sexual development. Population density affects earthworms differently depending on species. Population density increases earthworm mortality, cocoon output, and development rate, according to a Rev Environ research. Earthworms develop slowly and have less biomass at higher population densities, even in ideal conditions. Many studies have shown the relevance of high earthworm populations in vermicomposting systems, with an optimal density of 1.60 kg-worms/m2 and a maximum feeding rate of 0.75 kg-feed/kg-worm/day. To enhance population development and reproduction, it's important to keep earthworm densities high while establishing a vermicomposting system.

B2. Microorganisms

Microorganisms in biodegradable organic waste help break it down under ideal conditions. As waste components are vermicomposted, the microbial population changes. Vermicomposting stabilizes organic materials using earthworms and microorganisms. Earthworms eat organic fungus for protein and nitrogen. Castings had a fungus population equal to or greater than original substrates. Microorganisms convert complex chemicals into plant-available forms and generate active molecules. One study found that not all bacteria consumed by earthworms during vermicomposting were killed during stomach transit. Earthworm intestines help spore formation. This certainly enhanced vermicompost's microbial biomass.

B3. Enzymes

Enzymatic activity is required for the full stabilization of chemically organic wastes. The worms' gizzards and intestines release enzymes that quickly biochemically convert organic waste's cellulosic and proteinaceous elements. As part of the vermicomposting process, enzymes such as celluloses, which depolymerize cellulose, b-glycosidase, which hydrolyses glycosides, amid hydrolase, proteases, and urease contribute to mineralization, and phosphatases, which remove phosphate groups from organic matter, all play significant roles. Indicators of microbial activity, such as enzyme activities, are frequently employed, and they may also be utilized to evaluate soil microbial metabolism intensity. Decomposition and detoxification of pollutants are two processes whose initiation and acceleration are aided by enzymes.

Conclusion

Earthworm species can manage cattle, municipal, agricultural, industrial, and wastewater residuals. Earthworms recycle industrial waste into vermicompost. To make high-quality vermicompost, mix earthworms with industrial trash. Vermicomposts have better chemical and physical properties than regular composts. Waste-based vermicomposts provide plant nutrients. Vermicompost is an effective soil conditioner and plant food. Once composted, the worms can be recovered and reintroduced. If the physical and chemical characteristics of industrial organic waste are preserved, vermicompost can be created. Vermicompost conditions soil and nourishes plants. Most research show that using alien worm species for vermicomposting harms worm diversity.

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