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# Enhancing humanure compost: A comprehensive analysis of physical and chemical characteristics before and after microbial consortium enrichment

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## Abstract
Researchers explore sustainable agriculture through humanure composting, turning waste into a nutrient-rich fertilizer. The compost enhances soil structure, reducing reliance on synthetic fertilizers. Safety is ensured with a microbial consortium. This aligns with environmental stewardship, emphasizing the circular use of organic matter. The experiment assesses humanure compost properties before and after microbial enrichment. Enriched compost shows improved water-holding capacity, a slight pH decrease, and increased nutrient levels. Heavy metal assessment confirms compliance with municipal solid waste compost standards.

**Keywords:** Humanure compost, microbial consortium, organic matter

## Introduction
In pursuing sustainable and eco-conscious agricultural practices, researchers and practitioners are exploring innovative solutions to address the challenges posed by conventional waste management and soil enrichment. One such frontier in this endeavor is the utilization of humanure compost, a process that transforms human waste into a nutrient-rich fertilizer. This novel approach not only addresses critical issues of waste disposal but also holds the potential to revolutionize soil fertility and crop productivity.

The compost, rich in nitrogen, phosphorus, and essential nutrients, serves as a potent organic fertilizer, fostering improved soil structure and microbial activity. Its application in agriculture has the potential to reduce reliance on synthetic fertilizers, close nutrient cycles, and promote environmentally conscious farming practices. However, the implementation of humanure composting is not without risks. Pathogen elimination is a paramount concern, as improper treatment during the composting process could pose health hazards. Ensuring compliance with stringent safety standards and regulations is crucial to mitigate these risks. Additionally, cultural and social acceptance of using human waste in agriculture remains a challenge.

Enriching humanure compost with a microbial consortium is imperative to optimize the composting process and ensure safe, nutrient-rich fertilizer production. Humanure, being a complex organic material, requires the collaborative efforts of diverse microorganisms to break down effectively. Introducing a microbial consortium accelerates the decomposition of organic matter in human waste. This enhanced microbial activity speeds up the composting process and contributes to the thorough elimination of potential pathogens, making the compost safer for agricultural use. Moreover, the microbial consortium ensures a balanced breakdown of different components in humanure, resulting in a more stable and nutrient-dense end product.

Enriching humanure compost with a diverse and well-balanced microbial community, not only harnesses the natural processes of decomposition but also creates a sustainable and effective solution for recycling human waste into a valuable resource for soil enrichment in agriculture. This approach aligns with principles of environmental stewardship, promoting a circular and responsible use of organic matter in the pursuit of sustainable practices. By keeping the above, the present experiment is carried out to study the physical and chemical properties of humanure compost before and after enrichment with the microbial consortium.

## Materials and Methods

This study was conducted at the Department of Soil Science and Agricultural Chemistry, GKVK campus, UAS, Bangalore, in the year 2022. The enrichment procedure involves combining 2 ml of the liquid microbial consortium with 100ml of water for every kilogram of humanure compost. The resultant mixture is thoroughly blended and subjected to regular watering twice a week to maintain a moisture content range of 60-70%. Placed under shade, the mixture is given a 15-day period to facilitate the proliferation of the microbial population. Standard protocols outlined in Table 1 were employed to assess various physical and chemical aspects of both enriched and unenriched humanure compost. The microbial consortium includes *Azotobacter chroococcum, Bacillus megatherium, Fraturia aurantia, Pseudomonas fluorescens, and Trichoderma viridae*.

**Table 1:** Methods followed for analysis of humanure compost before and after enrichment

| Parameter | Method | Reference |
|---|---|---|
| **Physical properties** | | |
| MWHC (%) | Keen Raczkowski Cup | Piper, 1966 [5] |
| **Chemical properties** | | |
| pH (1:10) | Potentiometry | Jackson, 1973 [1] |
| EC (dS $m^{-1}$) | Conductometry | Jackson, 1973 [1] |
| Organic carbon (%) | Wet oxidation | Walkley and Black, 1934 [7] |
| Total Nitrogen (%) | Kjeldahl distillation method | Piper,1966 [5] |
| Total Phosphorus (%) | Spectrophotometry | Piper,1966 [5] |
| Total Potassium (%) | Flame photometery | Piper, 1966 [5] |
| Total Calcium (%) | Versenate titrimetry | Jackson, 1973 [1] |
| Total Magnesium (%) | Versenate titrimetry | Jackson, 1973 [1] |
| Total Sulphur (%) | Turbidometry | Jackson,1973 [1] |
| Total Fe, Mn, Zn and Cu (ppm) | Atomic Absorption<br>Spectrophotometry | Lindsay and Norvell, 1978 [2] |
| Total B (ppm) | Azomethane-H | Page *et al.*, 1982 [4] |
| Total heavy metals (ppm) | Atomic Absorption | Lindsay and Norvell, 1978 [2] |

## Results and Discussion

The experiment results are highlighted In Table 2, the water-holding capacity reveals a slight increase in moisture content in enriched humanure compost (HC) (51.14%) compared to its pre-enrichment state (50.47%). The pH of HC, initially at 6.45, experienced a marginal decline to 6.44 post-enrichment, potentially due to the generation of organic acids and phenolic compounds during incubation. Nevertheless, the pH stabilized over time, likely influenced by the buffering characteristics of humic substances.

The soluble salt content in HC increased from 1.61 dSm-1 before enrichment to 1.64 $dSm^{-1}$ post-enrichment, suggesting a rise in electrical conductivity linked to increased salt concentration, possibly originating from organic matter decomposition. The initial organic carbon (OC) content in HC was 12.41%, decreasing to 11.36% after enrichment, indicating an overall decline attributed to carbon loss in the form of carbon dioxide ($CO_2$).

The carbon-to-nitrogen (C: N) ratio decreased from 7.56 before enrichment to 6.38 after 15 days, indicating a decrease in organic carbon content and an increase in nitrogen due to mineralization. The nitrogen content in HC increased from 1.64% to 1.78% after enrichment, associated with the breakdown of labile organic carbon compounds

**Table 2:** Physical and chemical composition of humanure compost (HC) before and after enrichment

| Parameters | Before Enrichment | After Enrichment |
|---|---|---|
| | HC | HC |
| MWHC (%) | 50.47 | 51.14 |
| pH (1:10) | 6.45 | 6.44 |
| EC (dSm-1) | 1.61 | 1.64 |
| OC (%) | 12.41 | 11.36 |
| C:N ratio | 7.56 | 6.38 |
| N (%) | 1.64 | 1.78 |
| P (%) | 1.08 | 1.20 |
| K (%) | 1.27 | 1.40 |
| Ca (%) | 2.41 | 2.41 |
| Mg (%) | 0.71 | 0.71 |
| S (%) | 1.10 | 1.11 |
| B (mg $kg^{-1}$) | 13.56 | 14.71 |
| Cu (mg $kg^{-1}$) | 92.16 | 91.20 |
| Mn (mg $kg^{-1}$) | 341.80 | 347.87 |
| Zn (mg $kg^{-1}$) | 125.13 | 129.87 |
| Fe (mg $kg^{-1}$) | 221.67 | 227.41 |
| Ni (mg $kg^{-1}$) | 4.67 | 4.66 |
| Cd (mg $kg^{-1}$) | ND | ND |
| Pb (mg $kg^{-1}$) | 14.60 | 14.60 |
| Cr (mg $kg^{-1}$) | 5.13 | 5.13 |

Before enrichment, phosphorus (P) content in HC was 1.08%, rising to 1.20% post-enrichment, likely due to the introduction of a microbial consortium facilitating an efficient mineralization process. Potassium (K) content increased from 1.27% to 1.40% after enrichment, possibly linked to swift microbial activity.

Calcium (Ca) and magnesium (Mg) content in HC remained nearly unchanged post-enrichment (2.41% and 0.71%, respectively), while sulfur (S) content remained constant at 1.10%. Micronutrient concentrations were slightly increased after enrichment, likely owing to organic chelation.

Heavy metal assessment revealed that no detection of cadmium. Concentrations of Ni, Pb, and Cr remained almost unchanged before and after enrichment, aligning with observations of lower heavy metal concentrations in compost prepared from municipal solid waste. This consistency with standards was noted by Stillwell and David (1993) [6] and Manju *et al*. (2013) [3].

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