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Comparative Analysis of Physicochemical Parameters in Enriched and Unenriched Farmyard Manure

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ABSTRACT: The non-enriched FYM may contribute to a less dynamic and resilient soil ecosystem, potentially necessitating increased reliance on synthetic fertilizers and pesticides hence, in this study, FYM underwent an enrichment process using a liquid microbial consortium. Unenriched FYM had slightly lowered moisture (41.21%) due to reduced bulk density. Enrichment with microbes raised moisture (42.32%) and slightly increased electrical conductivity.

Total organic carbon remained stable, but nitrogen and phosphorus increased post-enrichment. Potassium, calcium, and magnesium stayed unchanged. Enrichment notably raised sulfur, zinc, and boron levels and slightly increased copper, manganese, iron, and nickel. No cadmium or leads were found, while chromium and nickel were below Indian standards.

Enriching FYM with microbes boosts nutrient availability, soil health, and crop yields. It enhances organic matter decomposition, fostering a diverse microbial community for improved soil structure and nutrient cycling. This practice increases soil carbon, aiding water retention capacity. In essence, enriching FYM with microbial consortia is a cost-effective; eco-friendly means to enhance soil fertility, crop productivity, and long-term agricultural sustainability.

Keywords: Organic carbon, FYM, crop productivity, soil fertility.

INTRODUCTION

Farmyard Manure (FYM) has been an integral component of agriculture for centuries, serving as a cornerstone of sustainable and organic farming practices. FYM, also known as farmyard manure or simply animal manure, is a naturally occurring, nutrient-rich material obtained through the decomposition of organic substances like animal dung, bedding, and plant residues in farmyards. It plays a crucial role in boosting soil fertility, enhancing soil structure, and fostering overall crop health. It serves as a potent source of essential nutrients, including nitrogen (N), phosphorus (P), and potassium (K), essential for the growth and development of plants. Additionally, FYM is a rich source of organic matter, which aids in enhancing soil structure, water retention capacity, and microbial activity. Together, all these characteristics contribute to higher crop yields and enhanced soil health.

As agriculture continues to evolve towards more sustainable and eco-friendly practices, the purpose of FYM remains paramount in ensuring food security and preserving health Unlike synthetic fertilizers, FYM is a renewable resource that can be produced on the farm itself, reducing the dependence on external inputs and minimizing carbon emissions linked with their production and transportation.

In the pursuit of sustainable and eco-friendly agricultural practices, the integration of microbial consortium enrichment in farmyard manure (FYM) has emerged as a promising innovation. Farmyard manure, a traditional source of organic nutrients has long been recognized for its role in enhancing soil fertility. However, as our understanding of soil microbiology advances, it becomes increasingly clear that harnessing the power of beneficial microorganisms can amplify the benefits of FYM, elevating it from a simple soil amendment to a dynamic tool for promoting soil health and crop productivity.

Microbial consortium enrichment involves the deliberate introduction of a diverse community of beneficial microorganisms into farmyard manure. These microorganisms play essential roles in nutrient cycling, disease suppression, and soil structure improvement (Parmar and Dufresne 2011). When combined with FYM, these microorganisms transform into a potent biofertilizer that supplies not only essential nutrients to crops but also enhances soil biology and resilience (Kundu and Gaur 1984). Keeping this view, the present investigation was taken to investigate the deliberate changes undergone in the soil's physical and chemical characteristics under Enriched and Unenriched FYM.

MATERIAL AND METHODS

The current study was conducted in 2022 at the Department of Soil Science and Agricultural Chemistry, GKVK campus, UAS, Bangalore. The FYM was enriched with liquid microbial consortium composition (*Azotobacter chroococcum* + *Bacillus megatherium* + *Fraturia aurantia* + *Pseudomonas fluorescens* + *Trichoderma viridae*). The one kg of FYM is enriched by mixing 2 ml of liquid microbial consortium in 100 ml of water. Mixed thoroughly, conditioned by sprinkling water twice a week to maintain the moisture content in the mixer up to 60-70 percent, placed under shade, and allowed for proliferation of microbial population for 15 days. Various physical and chemical aspects of enriched and unenriched FYM samples were estimated using the stated standard protocols as presented in Table 1.

Table 1: Methods employed for the analysis of FYM pre- and post-enrichment.

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

RESULTS

A. Physical and chemical characteristics of FYM prior to enrichment with microbial consortia

The initial water-holding capacity of FYM was measured (Table 2) at 41.21%. Additionally, the sample exhibited an electrical conductivity of 11.15 dS m^{-1}, and the pH level was recorded as 7.65. The C to N ratio was determined to be 27.69, with an organic carbon concentration of 17.45%. Furthermore, essential nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, and sulphur were all present in concentrations of 0.63, 0.26, 0.57, 0.48, 0.17, and 0.22, respectively. The micronutrient analysis demonstrated the existence of specific concentrations of Boron at 10.40 mg kg^{-1}, iron at 114.80 mg kg^{-1}, manganese at 267.93 mg kg^{-1}, zinc at 113.40 mg kg^{-1}, and copper at 31.71 mg kg^{-1} respectively. Heavy metals analysis revealed specific concentrations of Lead at 5.53 mg kg^{-1}, chromium at 7.60 mg kg^{-1}, and Nickel at 2.47 mg kg^{-1}, with the absence of cadmium in the FYM sample is a noteworthy observation.

B. Physical and chemical properties of enriched FYM with microbial consortia

In the examination of enriched farmyard manure (FYM), clear observations revealed that the water-holding capacity reached 42.32%. The electrical conductivity recorded a value of 1.16 dS m^{-1}, while the pH remained neutral at 7.62. Additionally, the C: N ratio was determined to be 16.83% and organic carbon was 16.83%. Furthermore, the concentration of essential nutrients such as nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur, were found to be 0.77%, 0.34%, 0.67%, 0.47%, 0.18%, and 0.24%, respectively. Regarding micronutrient content, the analysis revealed specific concentrations for Boron, iron, manganese, zinc, and copper, measuring at 11.44, 118.27, 273.20, 122.93, and 31.65 mg kg^{-1}, respectively. Additionally, the investigation identified heavy metals Lead at 5.54 mg kg^{-1}, chromium at 7.60 mg kg^{-1}, and Nickel at 2.46 mg kg^{-1} within the FYM sample, while cadmium was not found in the analyzed FYM (Table 2).

DISCUSSION

Physical and chemical properties of Farm Yard Manure (FYM) before and after enrichment with microbial consortia. Water holding capacity (Table 2) was observed to be slightly lower in unenriched FYM (41.21%), which can be ascribed to decreased bulk density. However, the enrichment of FYM with microbial consortia did not significantly affect the moisture content (42.32%) or bulk density. It is noteworthy that the moisture content exhibited a slight increase in the enriched FYM (42.32%) than normal FYM (41.21%), likely due to their improved maturity and finer particle size, resulting in increased surface area and enhanced moisture-holding capacity.

The pH levels observed in both FYM samples were all close to neutral. The fluctuations in pH within the enriched FYM samples could likely be attributed to the existence of a relatively rich source of basic cations, particularly calcium, as previously discussed by Gajanan *et al*. (1999).

Furthermore, the electrical conductivity in enriched FYM was marginally greater than that in normal FYM. This elevation in electrical conductivity may be attributed to an increased concentration of salts arising from the decomposition of organic matter, a phenomenon reported by Francou *et al.* (2005).

The enrichment process did not lead to substantial alterations in the total organic carbon content but did result in an increase in nitrogen content. The FYM encountered a reduction in total carbon content, a change that can be ascribed to carbon loss in the form of carbon dioxide (CO_2), as previously reported by Goyal *et al*. (2005); Nishanth and Biswas (2008).

Furthermore, the carbon-to-nitrogen (C:N) ratio was found to be lower in enriched FYM than in normal FYM, which can be attributed to the increased nitrogen content per unit of material in FYM.

The increase in phosphorus content in the enriched FYM is caused by the enrichment process involving the introduction of microbial consortia. This enrichment likely facilitated more efficient mineralization processes, leading to a higher concentration of phosphorus content. These results are consistent with the findings of Terman *et al*. (1973); Reddy *et al*. (2000).

However, it is noteworthy that the content of potassium, calcium, and magnesium in both enriched and normal FYM remained largely unchanged and did not exhibit noteworthy enhancements with the enrichment of microbial consortia.

Table 2: Physical and chemical characteristics of FYM before and after enrichment with microbial consortium.

Parameters	Before Enrichment FYM	After Enrichment FYM
MWHC(%)	41.21	42.32
pH(1:10)	7.65	7.62
EC(dSm^{-1})	1.15	1.16
OC(%)	17.45	16.83
C:Nratio	27.69	21.85
N(%)	0.63	0.77
P(%)	0.26	0.34
K(%)	0.57	0.67
Ca(%)	0.48	0.47
Mg(%)	0.17	0.18
S(%)	0.22	0.24
B (mg kg^{-1})	10.40	11.44
Cu (mg kg^{1})	31.71	31.65
Mn (mg kg^{1})	267.93	273.20
Zn(mg kg^{-1})	113.40	122.93
Fe(mgkg^{-1})	114.80	118.27
Ni(mg kg^{-1})	2.47	2.46
Cd (mg kg^{-1})	ND	ND
Pb (mg kg^{-1})	5.53	5.54
Cr(mg kg^{-1})	7.60	7.60

Note: *FYM = FarmYard Manure; *ND = Not detected

The elevation in the level of sulfur, zinc, and boron was observed because of the enrichment process involving the inclusion of microbial consortium. Notably, the increase was more pronounced in enriched FYM compared to normal FYM. In contrast, the levels of copper, manganese, iron, and nickel remained constant, and these micronutrient levels were higher in enriched FYM compared to normal FYM.

Concerning the existence of heavy metals, cadmium was not detected and lead, chromium, and nickel were below the standards set by Indian regulations.

CONCLUSIONS

Enriching farmyard manure (FYM) with a liquid microbial consortium is a proven, sustainable agricultural practice. The process significantly improves soil properties, including increased moisture content, electrical conductivity, and enriched essential nutrients like nitrogen and phosphorus. This cost-effective strategy not only enhances nutrient availability but also promotes a diverse microbial community, contributing to improved soil structure, enhanced water retention, and increased crop yields ultimately supporting long-term agricultural sustainability.

FUTURE SCOPE

Further investigations can delve into optimizing the microbial consortium composition, application rates, and methods to fine-tune the enrichment process for different soil types and crops. Long-term field studies are essential to assess the sustained impact of enriched FYM on soil health, nutrient cycling, and crop yields over multiple growing seasons. Additionally, exploring the economic viability and scalability of large-scale adoption of this enrichment technique is crucial for practical implementation in diverse agricultural settings. Collaboration between researchers, farmers, and policymakers can facilitate the development of guidelines and recommendations for integrating microbial-enriched FYM into mainstream agricultural practices, contributing to a more sustainable and resilient agricultural system in the future.

Conflict of Interest. None.

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