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A Comprehensive Review of Compost Standards in India

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ABSTRACT

Composting serves as a vital approach in the realm of sustainable waste management, playing a significant role in nutrient recycling, enhancing soil fertility, and minimizing organic waste. This paper presents a comprehensive analysis of compost standards in India, including the Fertilizer Control Order (FCO) of 1985 and its subsequent amendments. Furthermore, it involves the compost standards outlined by the Bureau of Indian Standards (BIS) as well as the Municipal Solid Waste (Management and Handling) Rules, 2000. This review also facilitates global benchmarking by exploring international standards, such as the United States Environmental Protection Agency's (US EPA) 40 CFR Part 503, which regulates pollutant concentrations and cumulative loading limits for sewage sludge, as well as the European Union Regulation (EU) 2019/1009, specifically PFC 1(A)(I) concerning solid organic fertilizers. An evaluation highlights significant similarities and differences in aspects like heavy metal limits, pathogen thresholds, and nutrient levels. This paper highlights existing gaps, overlaps, and potential for harmonization within the standards, with the objective of fostering a comprehensive and sustainable compost quality framework that prioritizes environmental protection, soil health, and agricultural productivity.
Keyword: - Compost, Standards, Indian standards, International standards, Compost quality

1. INTRODUCTION

Composting effectively minimizes the reliance on chemical fertilizers, decreases waste materials, and conserves landfill space. The established standards significantly influence engineering design and operational decisions. Additionally, compost quality standards are crucial for marketing and beneficial utilization of compost, as well as for the growth of urban waste composting initiatives [1]. Currently, there is a lack of comprehensive literature addressing the existing compost standards in India. This paper presents a comprehensive compilation of composting standards and the role of agencies, facilitating a comparison between the data and both Indian and international standards. This paper is designed to assist policymakers, researchers, and industry stakeholders in holding regulatory best practices, pinpointing opportunities for harmonization, and encouraging the safe and effective application of compost in agriculture and environmental management.

2. COMPOST STANDARDS, INDIA

2.1 Fertilizer Control Order, 1985: Overview and amendments regarding compost standards

The Fertilizer Control Order (FCO) of 1985, administered by the "Department of Agriculture Cooperation," "Government of India," was issued under the "Essential Commodities Act" of 1955. The FCO outlines the criteria for substances that can be used as fertilizers in soil, including product specifications, sampling and analysis methods, the process for obtaining licenses or registration as a manufacturer or dealer in fertilizers, and the conditions that must be met for trading these products [2]. **Table 1** describes the FCO specification for compost and vermicompost. This includes limits for nutrients, pathogens, and heavy metals. Despite several amendments to the FCO standards in 2013, 2021, 2023, 2024, and 2025, the established limits for compost quality, especially regarding heavy metals and nutrient content, have remained unchanged.

Table -1: Schedule IV, Specification for compost and vermicompost (The FCO, 1985).

S/N	Characteristic	Compost	Vermicompost
1.	Moisture, percent by wt.	15.0-25.0	15.0-25.0
2.	Color	Dark brown to black	Dark brown to black
3.	Odor	Absence of foul odor	Absence of foul odor
4.	Particle size	A minimum of 90% of the material should pass through a 4mm sieve	A minimum of 90% of the material should pass through a 4mm sieve
5.	Bulk density (g cm^{-3})	0.7-0.9	0.7-0.9
6.	TOC, percent by wt., minimum	16.0	18.0
7.	TN (as N), percent by wt., minimum	0.5	1.0
8.	TP (as P_2O_5)	0.5	1.0
9.	TK (as K_2O), percent by wt., minimum	0.5	1.0
10.	C/N ratio	20:1 or less	-
11.	pH	6.5-7.5	-
12.	Conductivity (dS m^{-1}), maximum	4.0	-
13.	Pathogens	Nil	-
14.	Heavy metal content (as mg/kg), percent by wt., maximum		
	As (as As_2O_3)	10.00	10.00
	Cd	5.00	5.00
	Cr	50.00	50.00
	Cu	300.00	-
	Hg	0.15	0.15
	Ni	50.00	50.00
	Pb	100.00	100.00
	Zn	1000.00	-

Ref. [3]

2.2 Bureau of Indian Standards for compost

IS 16556:2016 (reaffirmed 2021): This standard prescribes the details of requirements of MSW compost, packing and marking of compost, sampling, and test methods for municipal solid waste compost.

IS 16702 2018: This standard prescribes the requirements for vermicompost, packing and marketing rules, methods for sampling, and test methods for vermicompost. **Table 2** describes the BIS requirements for MSW compost and vermicompost. This includes limits for nutrients, pathogens, and heavy metals.

Table -2: BIS requirements for MSW compost and vermicompost (Clause 4.3).

S/N	Characteristic	MSW compost	Vermicompost
1.	Moisture, percent by wt.	25 (maximum)	15.0-25.0
2.	Color	Dark brown to black	-
3.	Odor	Absence of foul odor	-
4.	Particle size	At least 90% of the material should pass through a 4mm sieve	-
5.	Bulk density (g cm^{-3})	1.00 (maximum)	0.7-0.9
6.	TOC, percent by wt., minimum	14	18.0
7.	TN (as N), percent by wt., minimum	0.8	1.0
8.	TP (as P_2O_5), percent by wt./mass, minimum	0.4	0.8
9.	TK (as K_2O), percent by wt., minimum	0.4	0.8
10.	C/N ratio (maximum)	20:1	20:1
11.	pH	6.5-7.5	6.5-7.5
12.	Conductivity (dS m^{-1}), maximum	4.0	4.0
13.	Pathogens	Passes the pathogenicity test	Absence
14.	Heavy metal content (as mg/kg), percent by wt., maximum		
	As (as As_2O_3)	10.00	10.00
	Cd	5.00	5.00
	Cr	50.00	50.00
	Cu	300.00	300.00
	Hg	0.15	0.15
	Ni	50.00	50.00
	Pb	100.00	100.00
	Zn	1000.00	-
Ref. [4][5]			

2.3 MSW (Management and Handling) Rules, 2000–Schedule IV, standards for composting.

The following requirements for compost quality must be fulfilled in order to ensure the safe compost application. **Table 3** describes the MSW (Management and Handling) Rules, 2000, standards for composting.

Table 3: MSW (Management and Handling) Rules, 2000, standards for composting.

Parameters	Maximum concentration, mg/kg dry basis (except pH and C/N ratio)
As	10.00
Cd	5.00
Cr	50.00
Cu	300.00
Pb	100.00
Hg	0.15
Ni	50.00
Zn	1000.00
C/N ratio	20-40
pH	5.5-8.5
Ref. [6]	

3. INTERNATIONAL COMPOST STANDARDS

In the European Union, the regulation of compost marketed as a fertilizing product falls under EU Regulation (EU) 2019/1009. This regulation establishes standardized guidelines for the quality, safety, and labeling of compost throughout all EU member states. **Table 4** shows the EU Fertilizer Regulation standards for solid organic fertilizer. In the context of the US-EPA, it is essential that vermicompost or worm castings adhere to the standards set forth in EPA 40 CFR 503 for the finished product. **Table 5** shows the US-EPA 40 CFR 503 limits.

Table -4: EU fertilizer regulation standards for solid organic fertilizer.

S/N	Parameters	EU 2019/1009, PFC 1(A)(I): Solid organic fertilizer (In cases where a solid organic fertilizer includes more than one declared primary nutrient)
1.	TOC, percent by mass, minimum	15
2.	TN (as N), percent by mass., minimum	1
3.	TP (as P_2O_5), percent by mass, minimum	1
4.	TK (as K_2O), percent by mass, minimum	1
5.	Pathogens	*Salmonella* spp.: Absence in 25 g or 25 ml *Escherichia coli* or *Enterococcusi*: 1000 in 1 g or 1 ml
6.	Heavy metal content, mg/kg (dry matter), maximum	
	Inorganic As	40
	Cd	1.5
	Cr (VI)	2
	Cu	300
	Hg	1
	Ni	50
	Pb	120
	Zn	800
Ref. [7]		

Table -5: US-EPA 40 CFR 503 limits: Pollutant concentrations and loading rates–sewage sludge.

S/N	Pollutant	Ceiling concentration (mg/kg dry wt.)	Pollutant concentration (mg/kg)	Cumulative pollutant loading rates (kg per ha.)	Annual pollutant loading rate (kg per ha. per 365-day period)
1.	As (As_2O_3)	75	41	41	2.0
2.	Cd	85	39	39	1.9
3.	Cr	3000	1200	3000	150
4.	Cu	4300	1500	1500	75
5.	Hg	57	17	17	0.85
6.	Ni	420	420	420	21
7.	Pb	840	300	300	15
8.	Zn	7500	2800	2800	140
9.	Mo	75	-	-	-
10.	Se	100	36	100	5.0
Ref. [8]					

4. CONCLUSION

This review provides a comprehensive perspective on the regulation of compost quality by examining various standards, highlighting its significance for sustainable agriculture and effective waste management. The Fertilizer Control Order (FCO), 1985, along with its amendments, the Bureau of Indian Standards (BIS), and the Municipal Solid Wastes (Management and Handling) Rules, 2000, establish a comprehensive framework for the regulation of compost in India, specifically concerning MSW compost and vermicompost. The study highlighted that numerous amendments occurred in the FCO Standard (1985) over the past few years, but the compost standard (Schedule IV) remained unchanged. As per the FCO Standard (1985), the specific requirements for total organic carbon (TOC), nitrogen, phosphorus, and potassium in vermicompost exceed those outlined for compost standards. The FCO Standard (1985) clearly states that compost must be free from pathogens; however, there are currently no established standard limits for pathogens in vermicompost. In a comparable way, the standards set forth by BIS indicate that the standards for total organic carbon (TOC), nitrogen, phosphorus, and potassium in vermicompost are significantly higher when compared to those specified for MSW compost. The EU 2019/1009 regulation, specifically PFC 1(A)(I), delineates the specifications for solid organic fertilizers, addressing critical parameters such as nutrient content, heavy metal limits, and the presence of pathogens, including *Salmonella* spp. and *Escherichia coli* or *Enterococcusi*. The US-EPA 40 CFR 503 establishes limitations on pollutant concentrations and loading rates for sewage sludge, specifying standards that include ceiling concentration, pollutant concentration, cumulative pollutant loading rates, and annual pollutant loading rates for heavy metals. The absence of specifications regarding nutrients and pathogens within the US-EPA 40 CFR 503 limits is noteworthy. Improvements in monitoring mechanisms, revisions of permissible limits for contaminants, and the integration of more stringent pathogen standards have the potential to greatly enhance the safety and acceptance of compost. This review establishes an outline for aligning compost standards among various regulatory entities, advancing sustainable agricultural methods, and encouraging innovation in the management of organic waste.

5. DECLARATION OF COMPETING INTEREST

The authors disclose no conflicts of interest.

6. ACKNOWLEDGMENTS

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