

International Journal of Agriculture Extension and Social Development

Volume 8; Issue 11; November 2025; Page No. 47-50

Received: 09-09-2025

Accepted: 11-10-2025

Indexed Journal

Peer Reviewed Journal

Efficacy of different compost cultures on bioconversion of silkworm rearing waste into quality compost

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DOI: <https://www.doi.org/10.33545/26180723.2025.v8.i11a.2617>

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Abstract

The present field study was conducted to evaluate the efficacy of different compost cultures on decomposition efficiency and cost economics of silkworm rearing waste under farmer's conditions during 2019-20 and 2020-21 in Kolar district, Karnataka. Four treatments were imposed viz., 1 ton Silkworm rearing waste only (T₁), 1 ton Silkworm rearing waste + 3 kg cow dung + 2 liter cow urine + 1 kg UAS (B) compost culture (T₂), 1 ton Silkworm rearing waste + 20 kg rock phosphate + 1 kg *Trichoderma* sp (T₃) and 1 ton Silkworm rearing waste + 200 ltrs of prepared waste decomposer solution (T₄). Significant differences were observed among four treatments. T₁ required the longest decomposition period (281 days), while T₄ achieved the shortest (78 days), followed by T₂ (87 days). Compost recovery was highest in T₄ (88.96%) and T₂ (85.36%), compared with T₁ (72.41%). Maximum compost yield was recorded in T₄ (893 kg/ton; 22.32 t/ha), followed by T₂ (853.6 kg/ton; 17.87 t/ha), whereas the lowest yield was obtained in T₁ (724 kg/ton; 3.62 t/ha). Economic analysis revealed superior profitability for T₄, with the highest gross return (Rs. 44,640/ha), net return (Rs. 44,640/ha), and benefit-cost ratio (17.85). T₂ also performed well economically (Rs. 35,740/ha gross return; Rs. 32,757/ha net return; B:C ratio 11.98). The study clearly indicates that composting of silkworm rearing waste using waste decomposer consortia (T₄) or UAS (B) compost culture (T₂) ensures faster decomposition, higher compost yield, and greater economic benefits compared to conventional practices.

Keywords: Cattle dung, compost culture, waste decomposer, compost yield, economics

Introduction

Sericulture is an agro-based livelihood activity in India, providing sustainable income and rural employment, particularly for small and marginal farmers. Karnataka is the leading sericulture state which contributes around 48% of the total silk production in India. The climatic conditions of Karnataka favour sericulture throughout the year. The mulberry based silkworm rearing system not only produces valuable silk but also generates substantial quantities of organic residues such as uneaten mulberry leaves, silkworm litter, larval excreta, and bed waste. During silkworm rearing 100 disease-free layings (DFLs) consumes about 1,000 kg of mulberry leaves and produces approximately 300 kg of silkworm litter and 500 kg of leftover leaves. Improper disposal of these residues can cause environmental pollution and nutrient loss (Sannappa *et al.*, 2014) [12]. However, these wastes are rich in organic matter and essential nutrients, offering great potential for compost production. Recent analyses reveal that silkworm rearing residues contain higher nutrient concentrations (N 1.8-2.1%, P 0.3-0.6%, K 1.1-1.6%) than traditional farmyard manure,

making them suitable feedstock for organic composting (Das *et al.*, 2021) [12]. The usage of sericulture farm residue among farming community reported 50% of the sericulture farmers burning the residue as waste / fuel for cooking, 20% used as fodder for domestic animal and 20% of progressive farmers used as raw material for trenching and mulching activity for soil health management and remaining 10% for other purpose (Sudhakar *et al.*, 2018) [16]. Nevertheless, decomposition is often slow due to high lignocellulosic content and an unbalanced C:N ratio. The use of microbial inoculants can effectively overcome these constraints by accelerating organic matter degradation and enhancing compost quality. Bioinoculants such as *Trichoderma harzianum*, cow-based compost cultures, and waste decomposer consortia have been reported to enhance composting efficiency through active microbial metabolism (Kumar *et al.*, 2018; Singh *et al.*, 2019) [3, 15]. Bhanuprakash *et al.* reported that microbes, *T. viride* and *Paecilomyces* sp. found to be most effective in hastening the degradation of lignin and cellulose in the silkworm rearing waste that reduced was to 13.46 and 14.53%, respectively. Several

studies confirm that microbial inoculants improve compost maturity, nutrient enrichment, and humification (Mishra *et al.*, 2020; Pathak *et al.*, 2015) [5, 6]. However, limited studies have evaluated the comparative efficacy and cost economics of different compost cultures in bioconversion of silkworm rearing waste. Therefore, the present investigation was undertaken to assess the decomposition rate, compost yield, and economic feasibility of various composting treatments to promote sustainable waste recycling and circular bioeconomy practices in sericulture.

Materials and Methods

The experiment was conducted for two consecutive years during 2019-20 and 2020-21 at farmer's field of Chitnahalli and Kadudevandahalli villages of Kolar district, Karnataka with a view of utilizing the silkworm rearing waste by composting. The silkworm rearing wastes including litter, left over leaf, twigs and other bed wastes were collected from the farmer's rearing house and chapped the rearing waste or shoots using chapping machine. The organic wastes viz., cow urine and cow dung was also collected at the same premises. One ton chapped silkworm rearing wastes collected in a compost bag spreading mulberry twigs at the base layer followed by waste from rearing house is then spread over layer by layer as per composting process of each technology. Turning was given at regular intervals to provide aeration. Days for compost maturity were recorded from the physical appearance of the compost. The recovery percentage was worked out to find the quantity of compost produced from biomass used and was measured by the formula,

$$\text{Recovery (\%)} = \frac{\text{Weight of Compost} \times 100}{\text{Initial weight of biomass}}$$

The treatments included

- T₁: 1 ton silkworm rearing waste only (Farmer practice)
 T₂: 1 ton silkworm rearing waste + 3 kg cow dung + 2 liter cow urine + 1 kg UAS (B) compost culture
 T₃: 1 ton silkworm rearing waste + 20 kg rock phosphate + 1 kg *Trichoderma* sp
 T₄: 1 ton silkworm rearing waste + waste decomposer solution (2 kg jaggery in 200 litres of water + 10 g waste decomposer culture)

Cost benefit analysis was also worked out for each treatment based on input costs, yield of compost, and prevailing market rates. Data were statistically analyzed using standard procedures with significance tested at 5% probability.

Procedure for compost production for each compost technology

Farmer Practice (T₁): Most of the sericulture farmers dump the silkworm rearing waste near compost pit or road side due to lack of knowledge on proper usages of these raw materials as organic manure.

Compost Culture (T₂): One ton chapped silkworm rearing wastes collected in a compost bag spreading mulberry twigs at the base layer followed by waste from rearing house is then spread over. For each layer of residue spread the part of slurry prepared using 1 kg of compost culture with 3 kgs of

cowdung, 2 litres of cow urine and water. All the above steps are repeated in the stated sequence until the pit is filled with 1-2 feet above the pit height. To avoid rain, wind, and to maintain the moisture and temperature, the pit should be covered with polythene sheet. Water is sprayed time to time over the pit to attain 60-70 per cent moisture. 1st turning is done after 25-30 days of decomposition (UAS Bangalore compost culture).

Compost Culture (T₃): One ton of chapped silkworm rearing waste was collected and subjected to composting in a compost bag. A basal layer of mulberry twigs was first spread at the bottom, followed by successive layers of rearing house waste up to a height of 3 ft. For each layer of residue, cow dung slurry prepared using 1 kg of *Trichoderma harzianum* mixed with 20 kg of rock phosphate and water was uniformly applied. To prevent the effects of rain and wind, and to maintain optimum temperature and moisture, the compost pit was covered with a polythene sheet. Moisture content was maintained at 60-70% by periodic spraying of water. The first turning of the compost was carried out after 25-30 days of decomposition (CSRTI Mysore compost culture).

Waste decomposer (T₄): Mix 2 kgs of jaggery and one bottle of waste decomposer containing 20 g microbial consortium into 200 litres of water in a plastic drum. Stir the content of the drum with a wooden stick every day twice, cover it and place under shade. On 6th day, sprinkle 40 litres of waste decomposer solution from 200 litres to every layer of one ton chapped silkworm rearing wastes filled in a compost bag. From rest of 160 litres of waste decomposer solution, sprinkle 40 litres every day to compost pit within 4 days. Water is sprayed time to time over the pit to attain 60-70 per cent moisture. 1st turning is done after 25-30 days of decomposition

Results and Discussion

The efficacy of different compost cultures on the bioconversion of silkworm rearing waste into quality compost is presented in Table 1. The results indicated show a marked variation among the treatments in terms of decomposition period and compost recovery. The recovery percentage on a weight basis ranged from 72.41% in T₁ to 88.96% in T₄. The control (T₁) required the longest decomposition period (281 days) and recorded the lowest compost yield (724 kg ton⁻¹) with 72.41% recovery. The lowest recovery in T₁ may be attributed to slower degradation, greater loss of organic matter through respiration, and leaching during the extended decomposition period. In contrast, the waste decomposer consortia treatment (T₄) exhibited the shortest composting period (78 days) and highest recovery (88.96%). waste decomposer consortia were supplemented with jaggery solution, indicating that the readily available carbon source (jaggery) stimulated microbial proliferation and activity (Saha *et al.*, 2008; Pathak *et al.*, 2018) [11, 7]. The accelerated decomposition is attributed to the synergistic action of beneficial microbes enhancing enzymatic degradation of organic matter (Kumar *et al.*, 2018; Singh *et al.*, 2019) [3, 15]. Cow-based compost culture (T₂) and *Trichoderma* + rock phosphate treatment (T₃) also showed improved

performance, confirming the positive influence of microbial and nutrient enrichment in composting (Singh and Amberger, 1990; Pathak *et al.*, 2015)^[14, 6].

Further, compost yield varied significantly across treatments, with T₄ producing 893 kg ton⁻¹, followed by T₂ (853.6 kg ton⁻¹) and T₃ (826.4 kg ton⁻¹). Enhanced microbial activity in these treatments improved organic matter breakdown, resulting in superior humus formation. The microbial consortium along with jaggery-based activation provides a diverse pool of decomposers capable of efficient lignocellulose degradation in seri farm residues (Ramesh *et al.*, 2020)^[9]. These results align with earlier studies by Manivannan *et al.* (2009)^[8] and Mishra *et al.* (2020)^[5] emphasizing the role of microbial inoculants in improving compost quality and nutrient enrichment.

Economic evaluation (Table 2) revealed that the waste decomposer consortia treatment (T₄) was most profitable, with a net return of ₹44,140 ha⁻¹ and a benefit-cost ratio of 17.85, followed by T₂ (B:C ratio 11.98). The control (T₁) had the lowest B:C ratio (3.63). Microbial consortia-based composting reduced composting duration, increased yield,

and improved profitability, corroborating findings of Das *et al.* (2021)^[2] and Mishra *et al.* (2020)^[5]. Similar economic advantages of microbial inoculant-based composting have been reported in previous studies, where enriched composting systems not only enhanced compost yield but also reduced cost of production and improved overall profitability (Patil *et al.*, 2018, Reddy and Uma, 2020 & Sharma *et al.*, 2019)^[8, 10, 13].

The study clearly demonstrated that the incorporation of microbial inoculants and additives substantially improved both the biological efficiency and economic viability of composting sericulture farm residues. Thus, waste decomposer consortia supplemented with jaggery followed by UAS (B) compost cultures emerges as the most efficient, eco-friendly, and profitable technology for recycling seri-farm residues. This approach not only ensures rapid waste management and enhanced soil fertility but also provides a sustainable pathway for improving farmers' income and supporting circular bioeconomy in sericulture-based farming systems.

Table 1: Efficacy of different compost cultures on bioconversion of silkworm rearing waste into quality compost (Avg of Two Year data 2019-20 & 2020-21)

Sl. No.	Treatment details	Days taken for decomposition	% recovery on weight basis	Compost yield (kg/ton)	Compost yield (t/ha)
T ₁	1 ton Silkworm Rearing Waste only	281	72.41	724.00	03.62
T ₂	1 ton Silkworm Rearing Waste + 3 kg cow dung + 2 liter cow urine + 1 kg UAS (B) compost culture	87	85.36	853.60	17.87
T ₃	1 ton Silkworm Rearing Waste + 20 kg rock phosphate + 1 kg <i>Trichoderma harzianum</i>	105	82.64	826.40	14.38
T ₄	1 ton Silkworm Rearing Waste + Waste decomposer consortia (2 kg Jaggery in 200 litre water + 20gm waste decomposer consortia)	78	88.96	893.00	22.32
	S.E.m ±	2.84	3.54	7.75	1.55
	CD (0.05)	8.52	1.18	23.26	4.67

Table 2: Cost economics of different compost cultures on bioconversion of silkworm rearing waste into quality compost

Sl. No.	Treatment details	Gross cost (Rs./ha)	Gross Return (Rs./ha)	Net Return (Rs./ha)	B:C Ratio (Rs.)
T ₁	1 ton Silkworm Rearing Waste only	2000	7260	5260	3.63
T ₂	1 ton Silkworm Rearing Waste + 3 kg cow dung + 2 liter cow urine + 1 kg UAS (B) compost culture	2983	35740	32757	11.98
T ₃	1 ton Silkworm Rearing Waste + 20 kg rock phosphate + 1 kg <i>Trichoderma harzianum</i>	3591	28760	25169	8.00
T ₄	1 ton Silkworm Rearing Waste + Waste decomposer consortia (2 kg Jaggery in 200 litre water + 20gm waste decomposer consortia)	2500	44640	44640	17.85





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