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Research Paper

"Changes in Volume of Sandalwood Green and Dry Leaf Litter During Composting."

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ABSTRACT: *Composting is a process carried out by microorganisms, wherein the biomass of organic waste is reduced due to the utilization of organic compounds and evaporation of water. The present study aimed to investigate the rate of biomass reduction of sandalwood plant leaves. The experiment involved both dry and green leaves in two proportions: 100% and 50%. Cattle dung (100%) served as the control. The results showed that the biomass of leaf waste was reduced by 75-77% of the total initial volume, whereas cattle dung exhibited a reduction of only 57%. Notably, a higher reduction in biomass occurred during the initial phase of composting in both 100% and 50% leaf waste. Interestingly, in dry leaf waste, a greater reduction was observed in the 50% mixture compared to the 100% mixture, whereas in green waste, the reduction was more pronounced in the 100% mixture.*

KEY WORDS*: Sandalwood leaf, composting, green leaf, dry leaf, biomass reduction.*

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I. INTRODUCTION

Disposal of waste is a universal problem that necessitates alternative solutions. Composting is a viable approach to convert bioorganic waste into humus-rich organic compounds, known as compost [1]. This process is mediated by either soil-associated microorganisms or active microbial cultures present in cattle dung. Composting materials comprise biomolecules such as carbohydrates, proteins, and water content [2]. When organic waste is exposed to the environment and encounters microorganisms, degradation begins [3]. During decomposition, microorganisms produce enzymes that break down complex organic compounds into simpler forms, releasing various gases and water, ultimately leading to biomass depletion [4].

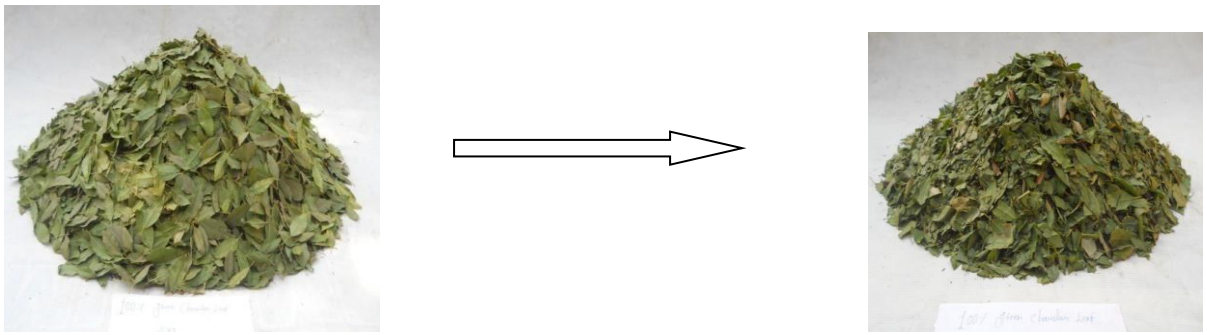
Sandalwood is a significant plant with diverse varieties found throughout most of India [5]. The wood of the sandal plant is either used directly for worship or its extracted oil is used for medicinal purposes. Sandalwood is a medium-sized hemiparasite plant characterized by large leaves [6]. The regular shedding of leaves creates pollution and an unhealthy atmosphere when decomposed improperly. The presence of lignin in the leaves makes decomposition challenging [7]. Effective leaf waste management requires special efforts. A survey report revealed that approximately 40% of India's total municipal solid waste consists of vegetable and leaf waste [8]. Leaf waste in urban areas originates from parks, institutions, and residential campuses. The Government Madhav Science College Ujjain (M.P.) has a botanical garden with a dense population of sandalwood trees, generating a substantial amount of leaf waste. This waste is managed through composting or vermicomposting. However, the continuous fall of leaves requires adequate space for management. This study aims to determine the rate of depletion of sandalwood leaves to optimize the volume of leaf waste in composting piles.

II. MATERIALS AND METHODS

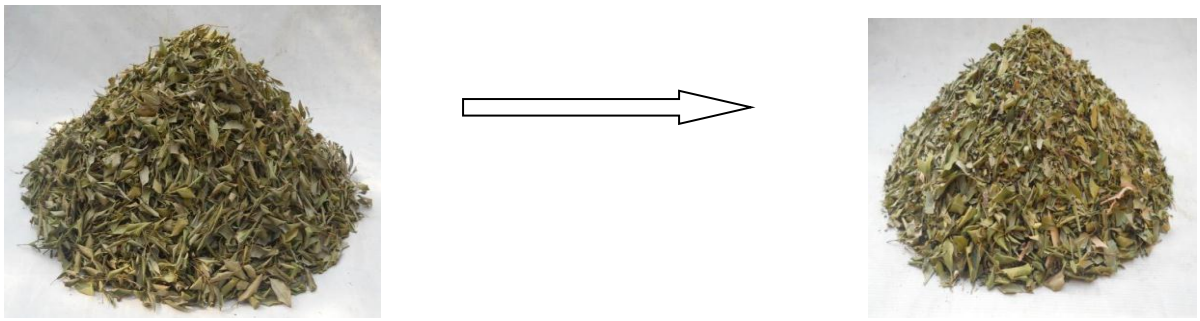
2.1 Collection of Leaf Litter Waste:

The dry leaf litter of *Santalum album* (commonly known as Sandalwood or Chandan tree) was used as a composting substrate. The leaf litter was randomly collected from the ground of the Government Madhav Science P.G. College campus, Ujjain (M.P.). Fresh leaves were directly plucked from the sandalwood tree. The

collected leaves were washed with tap water, followed by distilled water, to remove dirt and debris. The washed leaves were then air-dried under shade and stored in a cool, dry place for subsequent experimentation [9].



Un-chopped Green leaf — Chopped Green leaf



Un-chopped dry leaf — Chopped dry leaf

Photograph (1)

2.2: Collection of cattle dung:
Cattle dung was collected in plastic container from territory of college campus, Ujjain (M.P.), India [10].

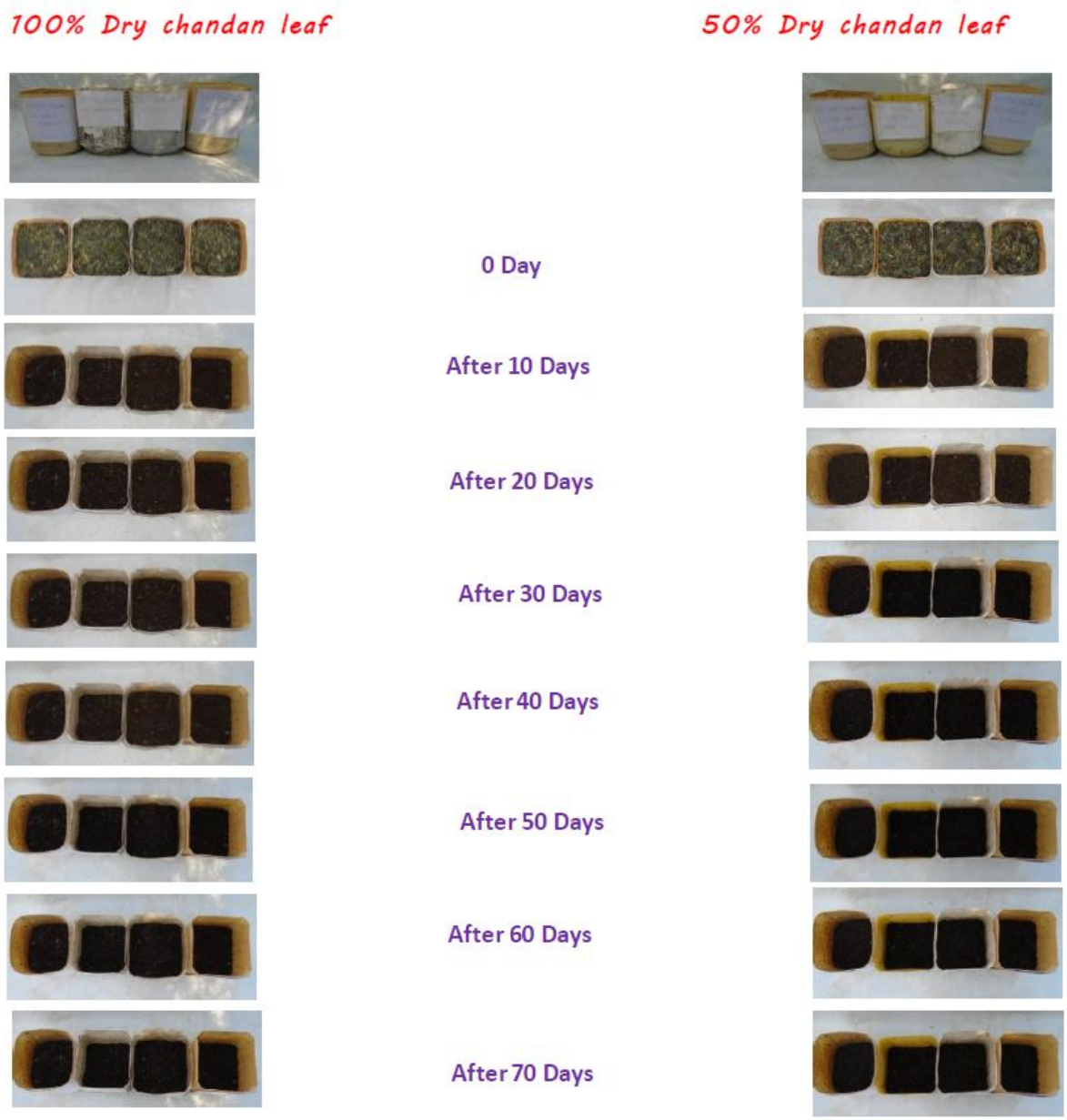
2.3: Preparation for composting:
The composting process was conducted in plastic containers measuring 25 x 25 x 25 cm. The collected leaf waste was chopped into small pieces (photograph 1) and mixed with cattle dung in a 50:50 ratio. Cattle dung and leaf waste were also used separately as controls (Table 1). The mixtures were placed in a concrete room and subjected to the windrow composting method, where the composting materials were left uncovered for passive ventilation. The waste materials were periodically agitated to enhance aeration [11]. After turning the bins, water was sprinkled on them to maintain high moisture content. The composting process was monitored until maturation, indicated by a black, granular appearance on the surface.
Table no.1: Representative mixture of leaf waste of green and dry Sandalwood cattle dung in different compositions.

S.No.	Leaf waste		Cattle dung	
	Percentage of waste	Quantity in kg.	Percentage of waste	Quantity in kg.
Dry leaf	100 %	2.0 kg	--	--
	50 %	1.0 kg	50 %	1.0 kg
Green leaf	100 %	2.0 kg	--	--
	50 %	1.0 kg	50 %	1.0 kg
Cattle dung	--	--	100 %	2.0 kg

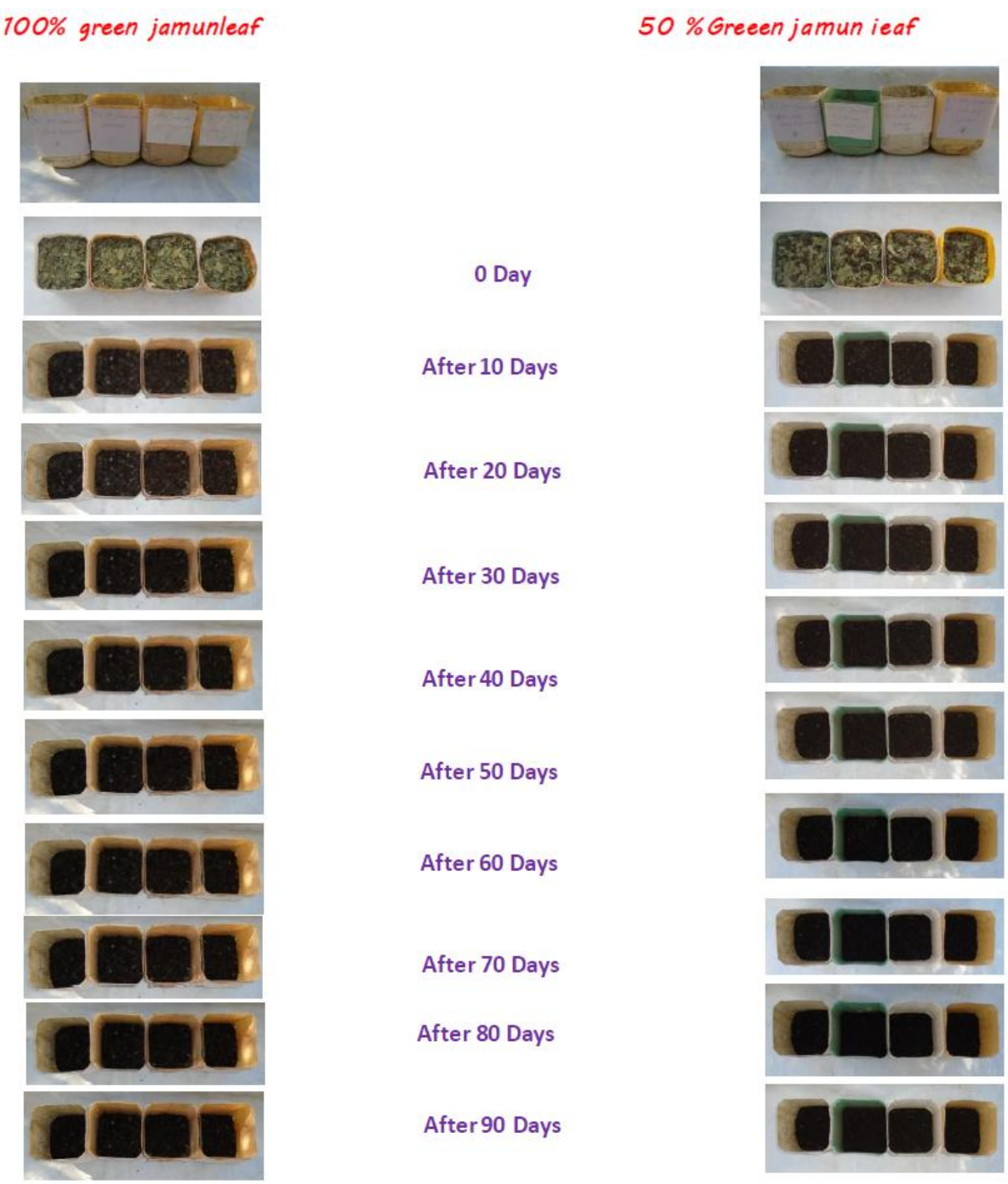
2.4: Measurement of biomass reduction:
The biomass reduction of dry and green leaf waste of the sandalwood plant, with and without the addition of cattle dung to the composting mixture, was measured using a plastic scale in centimeters. Measurements were taken at regular 24-hour intervals until the end of the process. Prior to use, the scale was disinfected with 70% alcohol and allowed to air dry. Composting materials were evenly spread in the composting bins. Before measuring the depth of the composting materials, the bins were gently tapped on the surface twice to ensure that gaps between leaf wastes were filled with adjacent materials. The scale was placed vertically on the composting materials on all four sides of the bin, and the length from the surface of the composting materials to the edge of the plastic bin was measured. A mark was made at the measurement site. The mean of the four measured values was calculated and recorded [12].

III. Result and discussion:

Biomass depletion was measured in various composition mixtures of green and dry leaf waste-cattle dung mixtures of Sandalwood plants. The results are presented in Table 2 and photograph 2 and 3. Initially, bins containing 100% dry and green leaf waste were nearly full, whereas those with 50% leaf waste were relatively less filled. The initial height of all proportions ranged from approximately 26 to 28 cm. During the composting process, the biomass height decreased, reaching approximately 6 cm at the end of the process. A significant reduction in biomass of up to 20 ± 1 cm was observed during the process.



Photograph (2): Different stages of composting of dry Sandalwood leaf waste.



Photograph (3): Different stages of composting of green Sandalwood leaf waste.

Table no. 2: Depleting the height of biomass of dry and green leaf waste of Sandalwood plant.

No. of weeks	Height of Dry leaf waste in cm.				Height of Green leaf waste in cm				Cattle dung	
	100 %	Loss In cm	50 %	Loss In cm	100 %	Loss In cm	50 %	Loss In cm	100 %	Loss In cm
1st	27.56	0.00	26.63	0.00	28.35	0.00	26.19	0.00	14.84	0.00
2nd	23.92	3.64	22.43	4.20	24.68	3.67	23.48	2.71	12.78	2.06
3rd	21.18	2.74	20.29	2.14	21.42	3.26	21.18	2.30	11.11	1.67
4th	19.90	1.28	18.33	1.96	18.26	3.16	19.57	1.61	10.68	0.43
5th	17.11	2.79	16.28	2.05	16.11	2.15	17.89	1.68	10.34	0.34
6th	14.53	2.58	15.58	0.70	13.24	2.87	14.73	3.16	9.72	0.62
7th	12.62	1.91	12.92	2.66	10.76	2.48	11.79	2.94	8.74	0.98
8th	10.48	2.14	9.41	3.51	9.29	1.47	9.28	2.51	7.95	0.79

9th	8.63	1.85	8.57	0.84	7.97	1.32	7.47	1.81	6.17	1.78
10th	6.95	1.68	6.75	1.82	6.89	1.08	6.65	0.82	6.15	0.02

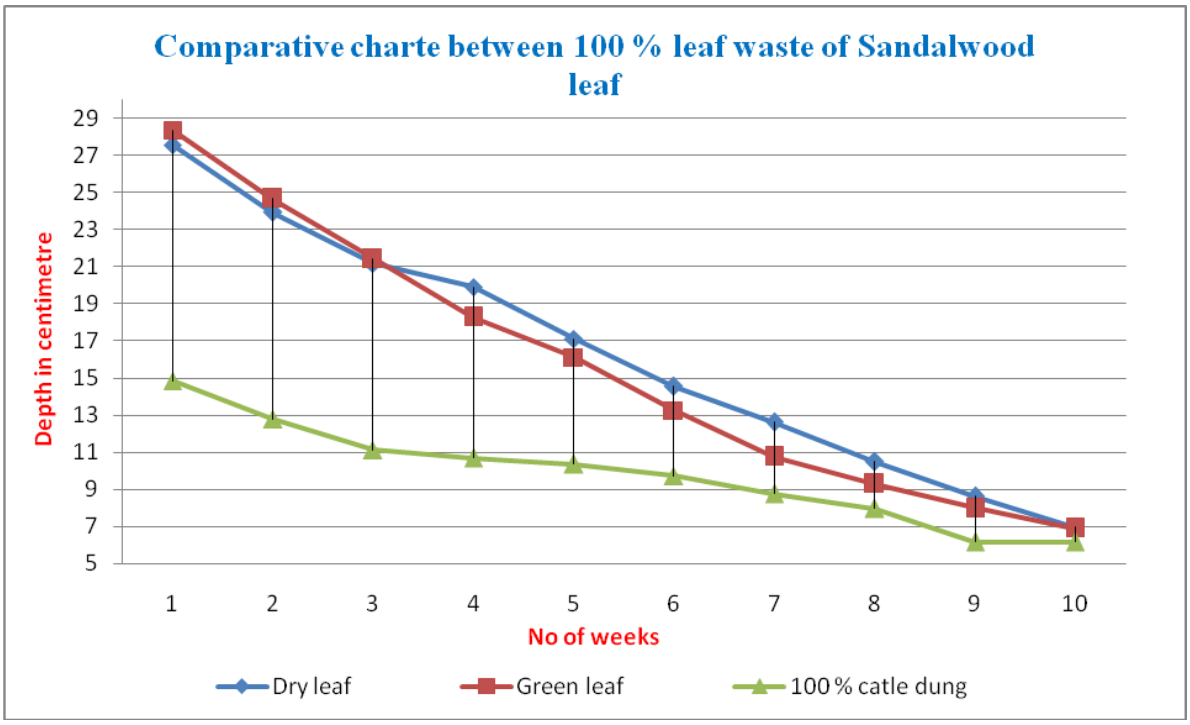


Figure. no.1: Depletion of biomass in 100 % green and dry leaf waste of Sandalwood plant.

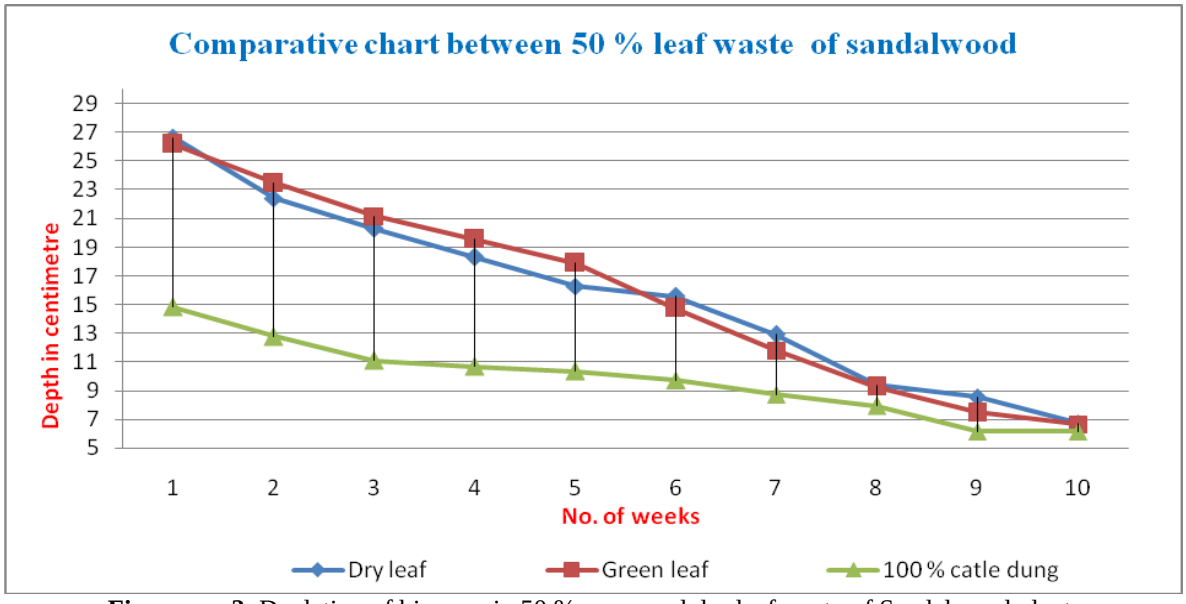


Figure. no.2: Depletion of biomass in 50 % green and dry leaf waste of Sandalwood plant.

Interestingly, we observed that in the 50% dry leaf waste mixture, depletion occurred to a greater extent than in the 100% dry leaf waste mixture . Conversely, in the green leaf waste mixture, depletion was more pronounced in the 100% mixture during the initial phase, while in the later phase, it was more significant in the 50% mixture (Figure. 1 & 2). The biomass of each plant part comprises organic compounds synthesized during photosynthesis. During storage, water is incorporated into these compounds, causing turgidity. This turgidity gives plant parts their definite shape, size, and volume. When microorganisms initiate the decomposition process, they exploit the plant's organic compounds, converting them into either their own biomass or releasing them as various gases [13]. This combined process results in the depletion of biomass volume.

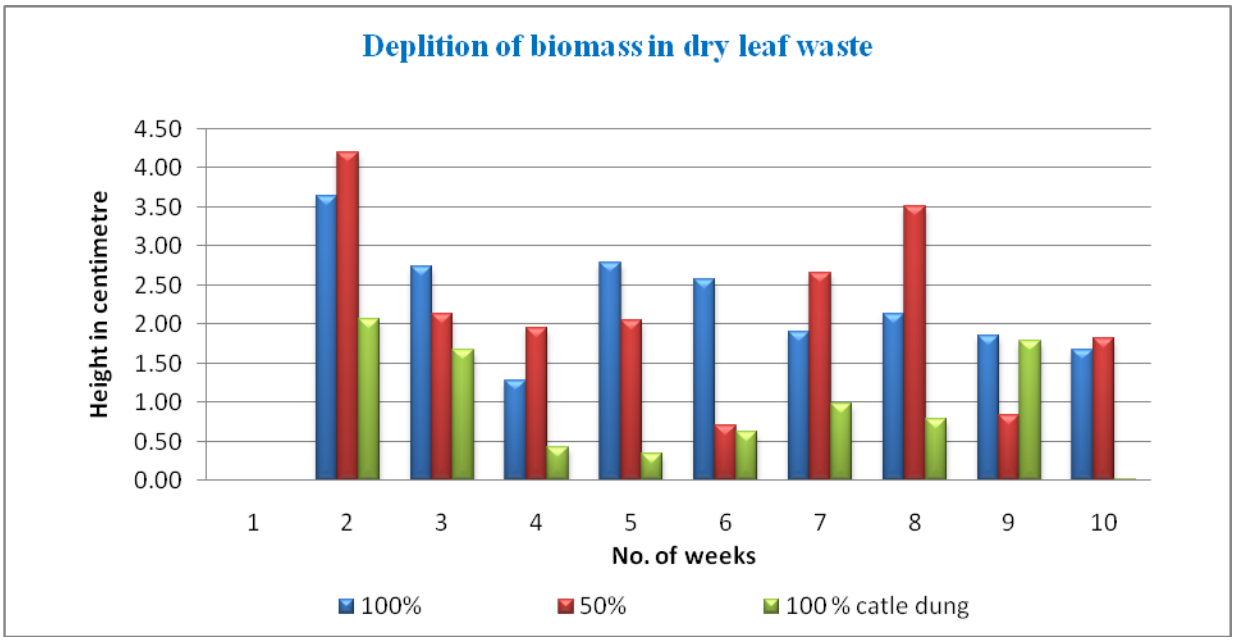


Figure. no. 3: Comparative study of depletion of biomass in dry leaf waste of Sandalwood plant.

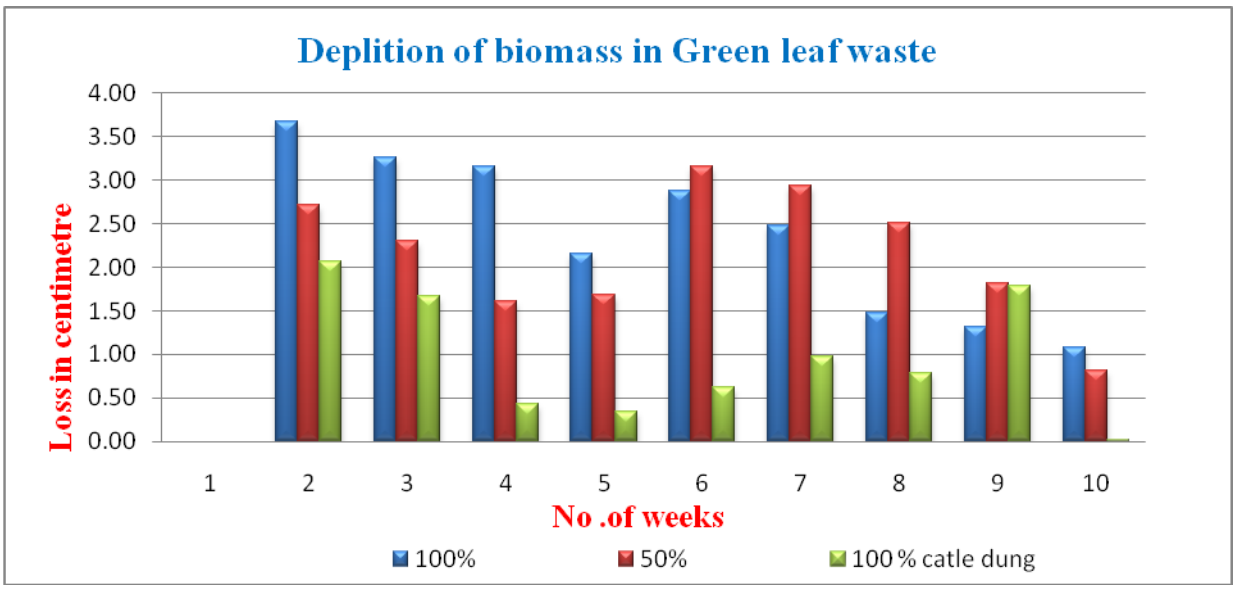


Figure. no. 4: Comparative study of depletion of biomass in green leaf waste of Sandalwood plant.

The first week of the composting phase saw the most significant depletion, primarily due to substantial water loss. Several studies have shown that the primary stage of composting is governed by thermophilic microorganisms, which generate excessive heat, leading to water loss in the form of vapor. Our results also revealed that greater depletion occurred during the first week in both dry and green leaf waste mixtures (Figures. 3 and 4).

The thermophilic phase was short-lived, lasting only a few days, before transitioning to the mesophilic phase. During this phase, microorganisms continuously utilized organic substances, generating heat that reduced biomass. As microbial activity continued, temperature increased due to heat generated through microbial oxidation. At this point, mesophiles were replaced by thermophilic organisms, which drove composting forward. From this period onward, stabilization occurred, marked by mineralization and humification, signalling the maturity stage [14], [15] and [16]. In our experiment, a similar pattern emerged between the 6th and 8th weeks, where the rate of biomass reduction increased

IV. CONCLUSION

Composting is a viable option for converting organic waste into nutrient-rich compounds known as compost. This process is facilitated by microorganisms present in both the air and cattle dung. Field trials have demonstrated that adding cattle dung to composting materials increases the rate of biomass reduction compared to using unaided cattle dung. However, the content of water and rapidly utilizable organic materials also impacts biomass reduction. The results of the present investigation suggest that allowing large amounts of initial biomass to decompose naturally in a spacious area can reduce its volume. Subsequently, transferring this content to a vermicomposting unit can further decompose the organic waste, requiring less space.

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