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Vermicomposting of Dry leaf litter of Palash (Bastard teak) tree (*Butea monosperma*)

Ritu Nagar[1], Anurag Titov[2], Praveesh Bhati[3*]
[1] Research Scholar, Govt. Madhav Science PG College, Ujjain, Madhya Pradesh, India
[2] Assistant Professor, Govt. Madhav Science PG College, Ujjain, Madhya Pradesh, India
[3] Scientific Officer, DNA Finger printing Unit, Sagar, Madhya Pradesh, India

Abstract
Disposal of waste is a universal problem. Available methods require manpower, lot of money and area to manage waste. Plant generating waste is a type of organic waste which can be use better for soil conditioning and as a tonic for maintain their healthy status. Vermicomposting is a suitable alternative for safe, hygienic and cost effective disposal of organic solid wastes. The present work has been done to reveal changes in physical factors during vermicomposting and also compare the result between different types of composting mixtures. The pH was measured during vermicomposting and found that at initial stage pH was 5.6 ± 0.1 in 100 % leaf litter (LL), 5.8 ±0.1 in 50% LL while 8.5 ± 0.1 in 100% cattle dung. At the end of process pH raised and set up to 8.1 ±0.1 in 100 % leaf litter 8.0 ±0.1 in 50% LL and 100% CD. Obtained result explore that temperate of 100 % leaf litter, 50 % leaf litter (LL) and 100 % cattle dung (CD) was slightly elevated (35.9, 36.5ºC and 38.5ºC ±1ºC respectively) at beginning phase and later came down to ambient level (21.5ºC ± 1ºC). The moisture content was recorded 48.25 % and 46.32 % in 100 % leaf litter, 50 % leaf litter (LL) respectively while 60.35 % recorded in 100 % cattle dung. During the initial time loss of water increased but latter stage was it was set at constant point. Reduction of biomass was also studied during process and found that in 100 % leaf litter biomass was reduce up to 22 cm; in 50 % leaf litter this reduction was found about 21cm while in 100 % cattle dung this reduction was found 8.6 cm.

Keywords: palash leaf litter, pH temperature, moisture, biomass reduction, vermicomposting

1. Introduction
Generation of leaf litters from the tree planted in public as well as private places is a major problem in term of their disposal (Alok and Tripathi, 2012) [1]. Conventional methods of amputation *viz*. burning, dumping not only make the environment polluted but it also affect the health of human being (Sannigrahi, 2009) [30]. Bio-organic waste required efficient way to sustain ecological temperament as well as improve natural resources (Tripathi and Bhardwaj, 2004) [40]. Composting is the splendid approach to resolve generated bio waste. It is an aerobic or anaerobic process involving several micro flora *viz*. bacteria, fungi and actinomycetes that assist in breakdown of organic matter to nutrient like compound humus (Shouche *et al*., 2011) [31]. Composting has numerous benefits but a few limitation requisite additional approaches to accomplish the demand. Vermicomposting is an improved part of composting but it differs from composting in several ways and it also faster than composting (Gandhi *et al.*, 1997) [8]. It is the result of combined activity of microorganisms and earthworms in which primary decomposition take place outside while secondary decomposition takes place inside the earthworm (Shouche *et al*., 2014) [32]. Different type of waste like sewage sludge, animal wastes, crop residues industrial refuse etc. have been recycle by different researchers through vermicomposting (Mitchell *et al*., 1980; Chan and Griaths, 1988; Hartenstein and Bisesi, 1989) [16, 7, 9]. Leaf litter is a byproduct of agriculture also processed through earthworm (Nagar *et al*., 2017a) [23]. The production of vermicompost from different leaf litters such as wheat straw (Indrajeet and Singh 2010) [11], Sugarcane leaf (Alagesan and Dheeba, 2010) [2], Ashoka tree leaf litter (*Polyalthialongifolia*), Teak tree leaves litter (*Tectonagrandis*) and Neem tree leaf litter (*Azadirachtaindica*) (Jayanthi *et al*., 2010) [12], Tendu leaf litter (Mushan and Rao, 2012) [18], Mango and Guava leaf (Vasanthi *et al*., 2013) [42], Rubber leaf litter (Nath and Chaudhuri, 2014) [25], Teak leaf litter (Nagalakshmi and Prakash 2016) [19], Eucalyptus (Nagar *et al*., 2017b) [24], Black plum (Nagar *et al*., 2018) [20], Sandelwood (Nagar *et al*., 2018; Bhati *et al*., 2019) [22, 6] have been reported There are several types of leaf litters have been used to produce vermicompost
Palash is a well known ornamental tree. It is also known as flame-of-the-forest and bastard teak. It is native to Indian Subcontinent and Southeast Asia (USDA, 2009) [41]. It is a medium-sized dry-season deciduous tree, growing to 15 m (49 ft) tall (Huxley, 1992) [10]. The leaf of this plant fall down covered the land. Although dry leaf is gradually decomposed enhance the nutrient level of the soil but it make more nutritious when processed through better way. Vermicomposting is an appropriate way to achieve this task. The main objective of the present study was to utilize Palash leaf litter (*Butea monosperma*) as raw materials for preparation of nutritious through vermicomposting.

2. Materials and Methods
2.1 Collection of Leaf Litter Waste
The fallen leaf litter of Palash (*Butea monosperma*) used as a substrate was collected at random from Govt. Madhav Science PG college Campus, Ujjain. Collected leaves were washed with distilled water in order to remove dust and

allow to air dry under shadow (Thangaraj, 2015) [39].

Un-chopped leaf Chopped leaf

Fig 1: Air dried plant leaves used in experiment.

2.2 Collection of Earthworms

Two exotic species *i.e*. *Eudrilus eugeniae* and *Eisenia foetida* were collected from vermiculture centre of Govt. Madhav Science College, Ujjain (M.P.) (Shouche *et al*., 2011) [31].

2.3 Vermicomposting of Palash leaf litter

Dry fallen leaf litter of the Palash tree was broken into small pieces of about 10-15 mm in size and 1.0 kg of the this materials were thoroughly mixed with 1.0 kg of old cattle dung with 1:1 ratio. Leaf litter thoroughly mixed with cattle dung and distributed into plastic bins. After 15 days when temperature came down to ambient level then 10-10 clitellate worms of each species (*E. eugeniae* and *E.foetida*) were inoculated into the vermicomposting bin. The bins were regularly watered during the period of study to maintain moisture of 65± 1 %. These bins maintained in triplicate till the granule like appearance was not seen (Singh *et al.*2004) [33].

2.4 Collection of Vermicompost Samples for Physical and chemical Analysis

Vermicompost samples collected from the initial stage (0-day) to different stages of vermicomposting process intermittently. Collected vermicompost allow to air dry and stored into freeze at 4 to 8ºC ±1ºC till the completion of experiment. There were several parameters were recorded as follow.

- Odor: It was determined by smelling directly. (Rodale, 1960) [29]
- Heating: It was determined by touch the surface as well as inserted hand inside the composting mixture (Rodale, 1960) [29].
- Granule size: It was measured by scale in millimeter (Rodale, 1960) [29]
- Color: It was determined by simply looking them (Shouche, *et al*., 2011) [31]
- pH: The pH was measured by pH meter (Shouche, *et al*. 2011) [31]
- Temperature variations: It was measured by using of mercury thermometer (Taiwo and Oso, 2004) [38].
- Moisture percentages (%): It was measured by placing of composting materials in hot air oven at 105^0C and taken their dry weight in order to find out moisture percentage. (Alidadi, 2005) [3]

3. Result and Discussion

Present study shows that odor of vermicomposting mixture was quite unpleasant during the beginning day and it was gradually changed and finally turned into earthen smell. It was also found that mixture of leaf litter –cattle dung was more stink than 100% cattle dung. The heat of Composting mixture was measure by insert hand into the mixture. It was found that mixture of leaf litter-cattle dung was of more heated than cattle dung. This heating was found more in early phase of composting but later it turned down and finally temperature set similar to room temperature. During composting process, granularity of composting mixture also noticed and found it was large size clump at beginning time but at the end of phase it turned into small granular form just like tea leaf granule. The color of composting mixture also recorded and it was found light greenish yellow color at initial phase but at the time of maturation of vermicompost, turned into dark brown color.

Table 1: Measured parameters during Vermicomposting of dry leaf litter of Plash tree.

S. No.	Collected sample	pH			Temp. (ºC)			Moisture			Biomass reduction		
		100% PLL	50% PL	CD	100% PLL	50% PL	CD	100% PLL	50% PL	CD	100% PLL	50% PL	CD
1	1st week	5.6	5.8.	8.5	35.9	36.5	38.5	48.25	46.52	60.35	29.28	28.13	14.84
2	2nd week	6.3	6.5	8.4	33.5	34.7	35.4	60.76	58.77	61.37	25.17	25.59	12.78
3	3rd Week	6.6	6.8	8.3	32.5	32.6	33.8	62.98	59.63	62.95	22.68	23.37	11.11
4	4th Week	7.0	7.1	8.2	30.4	31.6	32.5	63.52	60.55	63.83	18.24	22.28	10.68
5	5th week	7.2	7.3	8.2	28.4	29.3	29.9	65.83	63.60	64.69	16.95	20.94	10.34
6	6th week	7.3	7.5	8.1	27.5	27.6	27.5	67.43	64.75	64.89	14.74	15.84	9.72
7	7th week	7.5	7.6	8.1	25.2	26.2	25.5	68.38	65.60	65.65	12.55	12.79	8.74
8	8th week	7.7	7.8	8.0	23.6	24.7	24.7	69.21	65.98	66.28	10.86	10.38	7.95
9	09th week	7.8	7.9	8.0	22.3	22.8	22.9	70.28	65.87	66.35	9.56	9.47	6.17
10	10th week	7.9	8.0	---	22.1	22.7	21.5	70.65	66.7.	---	8.27	8.14	---
11	11th week	8.1	---	---	21.4	21.5	---	71.34	66.15	---	7.13	6.72	---
12	12th week	---	---	---	---	---	---	---	---	---	---	---	---
13	13th week	---	---	---	---	---	---	---	---	---	---	---	---

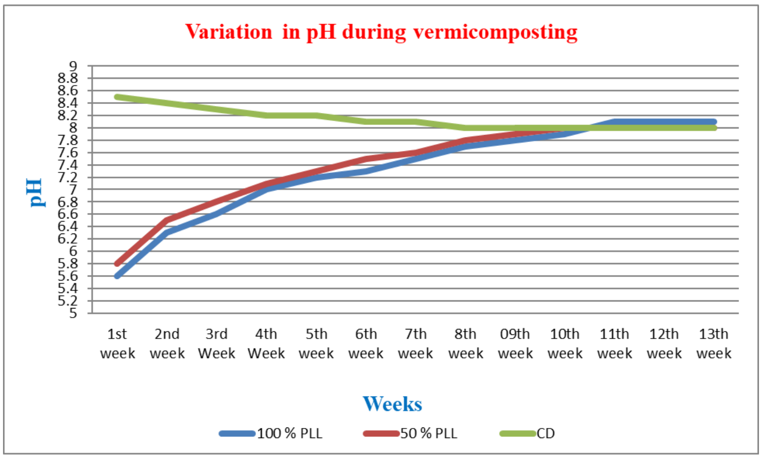

Fig 2: Graph showing variation in pH during vermicomposting.

In the present investigation the pH was found acidic in both 100% and 50 % leaf litter of Palash tree while alkaline in 100 % cattle dung. The pH of 100% and 50 % leaf litter of Palash tree were seen incline at the 10^{th} week of vermicomposting than it attained stable position while in case of 100 % cattle dung the pH level declined at the 10^{th} week of prices and also stable. The final pH of all combinations was recorded 8.0 ± 0.1 (table no.1 and photograph no.2). Parthasarathi *et al.*, (2007) [27], found decline in pH during vermicomposting while using of different organic waste *viz*. cow dung, horse dung, sheep dung and cashew leaf litter for production of compost. Sundaravadivelan *et al*. (2011) [36], reported that pH (7.49) was found in Mango leaf litter vermicompost of *Lampito mauritii* while in control pH (7.41). Higher pH reduction (2.1) was found in cowdung + teak leaf litter + waste cotton + *Lampito mauritii* (T5) 1:1 ratio than the pH reduction (1.8) recorded in cow dung + teak leaf litter + waste cotton + *Lampito mauritii* T6 (1:2). Prakash (2010) [28], noticed that maximum pH was recorded in the final teak leaf litter vermicompost (7.32) and lower in control (7.10). In our present study we also found that in 100% and 50 % leaf litter vermicomposting mixture of Palash tree**,** the pH was reduced up to 2.4 ±0.1 while in case of 100 % cattle dung it was changed about only 0.5 ±0.1 from initial level. Bhat, *et al*. (2014) [5], observed a decrease in pH during the process of vermicomposting of mixture of bagasse and cattle dung. The changes in the pH during vermicomposting are due to the mineralization of nitrogen and phosphorus compounds and the production of acids like humic and fulvic acid.

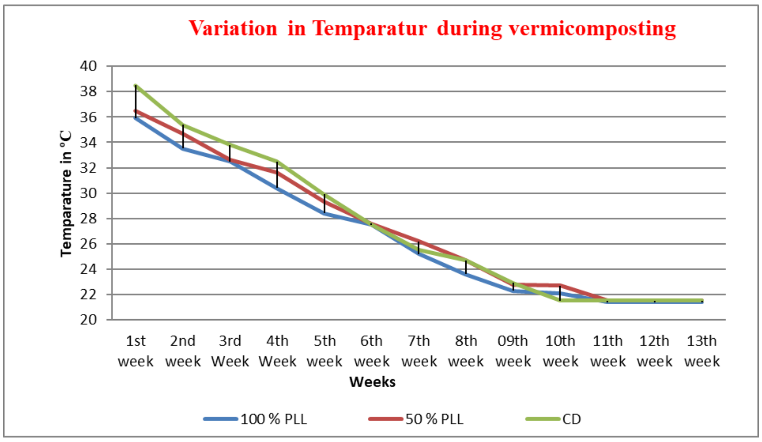

Fig 3: Graph showing variation in temperature during vermicomposting.

During vermicomposting of leaf litters of Palash tree, the temperature was also measured. It has found that in first week, the average temperature of leaf litters as well as cattle dung and their mixture were high. The temperature was decline till the 10^{th} week of vermicomposting period and later stable at constant point. Result also revealed that at first week, the temperature of leaf litters-cattle dung mixture (36.5ºC±1ºC) was higher than 100 % leaf litters (35.9ºC±1ºC) but lower than 100 %cattle dung (38.5ºC±1ºC) (table no.1 and photograph no.3). The region behind higher temperature in 100 % leaf litters is due to presence of microorganisms as well availability of undigested organic carbons that aerobically degraded by microorganisms and generate heat. In case of 100 % leaf litters although ample quantity of organic carbon was available but due to lake of microbial source (soil or cattle dung) only areal microorganism passively transferred and start decomposition process. Due to that their temperature was not as high as 100 % cattle dung. Initial temperature was raised because of biochemical processes and decomposition of organic components of waste. As soon as organic waste depleted the temperature also turn down and set at lower constant value (Lefebvre, *et al*., 2000) [13]. Rising of temperature at initial phase was noted by several researchers by using of organic waste *viz*. card board, news paper, paper towel, municipal sewage waste, floral waste etc. (Atchley and Clark, 1979; Mckinley and Vestal, 1985; Shouche *et al*., 2011) [4, 14, 15, 31].

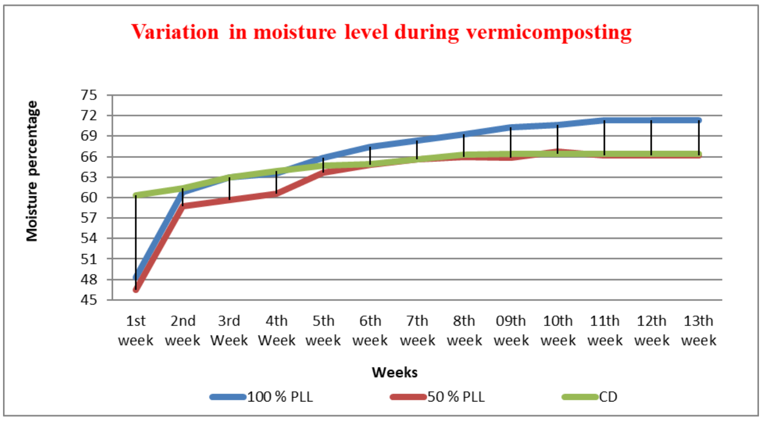

Fig 4: Graph showing variation in moisture level during vermicomposting.

Moisture content is an important physical factor essential for decomposition of organic waste. The decomposition process chiefly carried out by microorganisms followed by earthworm which work under adequate moisture level therefore present study we also measured moisture content of different organic waste taken in experiment. We found that moisture level rapidly changed at the beginning phase of vermicomposting but at the time of maturity of vermicompost it was remain constant around particular level. Obtained result also revealed that in 100 % cattle dung mixture (60 %), moisture level was higher than 100% leaf litter (48 %) and 50 % leaf litter-cattle dung mixture (46 %) at first week of vermicomposting phase. It has also found that, moisture level was rapidly increased in the second week of vermicomposting process in the mixture of 100% leaf litter and 50 % leaf litter-cattle dung mixture. After second week, increasing level of moisture level reduced but gradually changed seen continuously till the 10th week of vermicomposting phase. Our result was concordance with result of solid waste and food waste composting done by Suler-Finstein (1977) [35] and Sundberg (2003) [37].

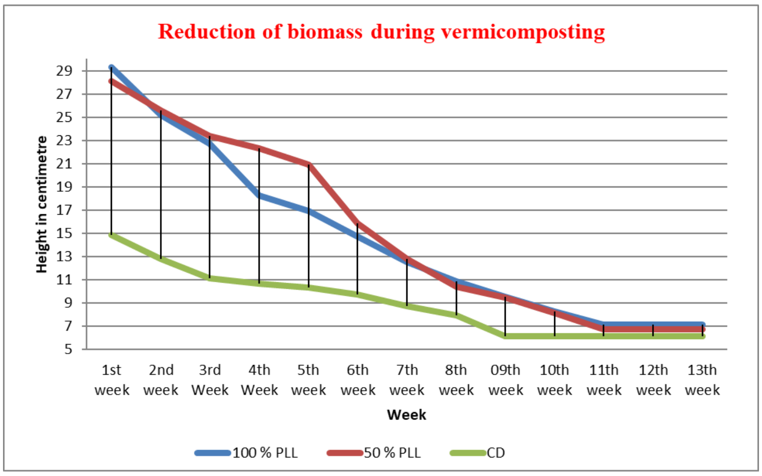

Fig 5: Graph showing reduction of biomass during vermicomposting.

Result found that initial height of composting mixture of 100 % leaf litter and 50 % leaf litter-cattle dung were 29.28 cm. and 28.13 respectively while the height of cattle dung mixture was 14.84 cm. During vermicomposting, the height of composting materials went decline and at the end of process set at the height of 6.0 cm ± 1cm. Present study also explored that the rate of biomass reduction affected by temperature, moisture content, nature of biomass and quantity of cattle dung (Nagar *et al*., 2018) [21]. The reductions in biomass are possibly due to loss of water in the form of water vapor and decomposition of complex organic waste into simplest form. Norbu (2002) [26] also carried out experiment on municipal solid waste and found that, biomass of waste reduced rapidly in first two week then it was set as constant level. Singh, *et al.* (2004) [33] were also concluded that the maximum depth reduction takes place in the first seven days and later it was established after 25 days. Similar observation was also recorded by Moqsud (2010) [17] who stated that composting was completed in about 35-40 days and the volume of the organic waste reduced 50-70 % of the original volume. Zheng (2004) [43] reported that microorganisms reproduced very rapidly at early stage of composting due to the abundance of easily-degradable organic matter. For this, the rate of volume reduction is usually fast.

4. Conclusion

Plant leaf litter wastes have become additional source of pollution, foul smells, unhygienic atmosphere and human health hazards. Their disposal and management is big challenge to the government and administration. In fact such nutrient rich wastes have possibilities to become the source of useful end products like compost. The purpose of present study is to find way of vermicomposting of Palash leaf litter. With this study we can conclude that addition of cattle dung with leaf litter in 1:1 ratio enhance the rate of decomposition. Addition of earthworm also improves the quality of the final product. During vermicomposting, we also analyzed different physical parameters *viz*. pH, temperature, moisture content and biomass reduction. After obtaining result we can say that at initial phase of vermicomposting, pH and temperature present at unfavorable level but later it changed and finally set at favorable level at which earthworm survive and carried out vermicomposting process. Our finding also suggests that during vermicomposting there is about 50-60 % height of leaf litter reduced from their initial height.

5. Acknowledgment

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