ISSN- 2350-0530(O), ISSN- 2394-3629(P)
DOI: 10.5281/zenodo.3262141

INTERNATIONAL JOURNAL OF RESEARCH – GRANTHAALAYAH
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Science

DIVERGENCE IN THE VERMICOMPOSTING OF GREEN AND SENESCENCE BLACK PLUM (*SYZYGIUM CUMINI*) LEAF LITTERS

Ritu Nagar [1], Anurag Titov [2], Praveesh Bhati [*3]
[1] Research Scholar, Govt. Madhav Science PG College, Ujjain, (M.P.), India.
[2] Assistance Professor, Govt. Madhav Science PG College, Ujjain, (M.P.), India
[*3] Scientific Officer, State Forensic Science Laboratory, Sagar (M.P.), India

Abstract

In the present scenario, generation of organic solid waste is foremost trouble demands healthy and sustainable elucidation. Vermicomposting is an appropriate biotechnological approach to transform organic solid waste into valuable product. Vermicomposting process is carried out by suitable exotic verities of earthworm. These Earthworms utilize semi digested organic waste include carbohydrate and protein as a source of food and produces vermicast which is rich in nutrients. Because more than 40 % part of city waste composed of plant materials therefore it can be a better utilizes in vermicomposting process. In the present experiment, plant material viz. Green leaf litters (GLL) and senescence leaf litter (SLL) of Black plum (*Syzygium cumini*) was taken and converted into vermicompost through *Eisenia foetida* and *Eudrilus eugenia*. Result revealed that vermicomposting mixture of both GLL and SLL showed similar trend in pH and temperature variation. The result of moisture contained revealed that SLL required more water to maintain adequate moisture than GLL. Total nitrogen content and total organic carbon were found more in GLL than SLL.

Keywords: Black Plum; Green Leaf Litter; Senescence Leaf Litter; Vermicompost; Earthworm.

Cite This Article: Ritu Nagar, Anurag Titov, and Praveesh Bhati. (2019). “DIVERGENCE IN THE VERMICOMPOSTING OF GREEN AND SENESCENCE BLACK PLUM (SYZYGIUM CUMINI) LEAF LITTERS” *International Journal of Research - Granthaalayah*, 7(6), 37-48. https://doi.org/10.5281/zenodo.3262141.

1. Introduction

Bioorganic-waste generated either by activity of human being or naturally (Akolkar, 2005). In India, about 700 million tons of solid organic waste generated annually which containing about 60 % of biological materials including leaves, husk, sawdust, steam bark, flowers etc (Bhiday, 1994). Plant materials are rich in decomposable materials synthesized by photosynthetic apparatus found in green part of plant such as leaf. The nutrient lavishness nature of leaf depends upon photosynthesizing compound, absorbed minerals from the soil, accessibility of water and physical factors viz. temperature and sunlight (Smith et al. 2000, Tausz et al. 2004). The availability of

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nutrients, perk-up the quality and quantity of plant products. Plant leaves are also play significant role as energy source for the microbes as well as major fauna of soil and water (França et al. 2009; Sarkar et al., 2010). These living creature decompose leaf litter and mineralize it with assimilation of energy (Shouche et al.,2014; Boulton and Boon, 1991).

Decomposition of leaf litters depends upon their physical and chemical property (Rincón and Santelloco 2009; Bruder et al. 2014). Although decomposing process help in nutrient cycling and procurement of elements for soil but with loss of certain nutrients also (Gandhi et. al., 1997). Vermicomposting is a better alternate for recycling of nutrient from leaf litters (Abbasi et al. 2009). There are immense effort have been done by several scientist towards the mineralization of leaf litters of different plant species by using of earthworms (Vasanthi, et al., 2013; Alagesan and Dheeba, 2010; Thangaraj, 2015; Nath and Chaudhuri ,2014 Nagalakshmi and Prakash2016).

Most of the study of leaf litter's vermicomposting is based on using of mature fallen leaves. In nature, plant leaf falling is common phenomenon which occurs by the process of senescence goverened by several biochemical changes (Jyothsna and Murthy 2016; Clément et al. 2017). At the end of maturation of leaf, when senescence starts, the available nutrients translocate from mature leaf to the other part of plant. (Diaz et al. 2008; Hollmann et al. 2014) It has been found that up to 70% of the leaf nitrogen translocat from senescent organs to other parts of the plant resulting less availability of nitrogen in mature fallen leaves than green leaves (Peoples and Dalling, 1988 ;Kochi and Yanai 2006).

Efforts also made to prepare compost from green leaves also (Landeiro et al. 2008; Martins et al. 2015; Gonçalves et al. 2017), sometimes with the rationalization that green leaves of plant signify and vital energy source (Lopes et al. 2015), or due to the unfeasibility of collecting senescent leaves in some ecosystems. Thus, the use of green leaves nearly always imply greater nutritional availability that allows for greater attractiveness to organisms associated with their Pre-composting followed by vermicomposting and therefore it assumes that their rates of decomposition are greater than the senescent leaves (Bastian et al. 2007).

In the present research is aim to evaluate this difference in vermicomposting coefficients between green and senescent leave of Black plum with using of two exotic verities of earthworm species i.e. Eudrilus eugenia and Eisenia foetida.

2. Materials and Methods

2.1. Collection of Leaf Litter Waste

The leaf litter of Black plum (Common Name: Jamun; Syzygium cumini) used as a substrate was collected at random from Govt. Madhav Science PG college Campus, Ujjain. The green leaf was plucked from tree at the time of experiment. Senescence leaf which had fallen also collected from ground around Black plum tree. Collected leaves were washed with distilled water in order to remove dust and allow to air dry under shadow (Nagar et al.,2017).

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
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2.2. Collection of Earthworms

Two exotic species i.e. Eudrilus eugeniae and Eisenia foetida from vermiculture centre of Govt. Madhav Science College, Ujjain (M.P.) (Bhati et al. 2011).

2.3. Vermicomposting of Black Plum (Syzygium Cumini) Leaf Litter

Black plum leaf litter waste was cut into smaller pieces of about 4-6 mm in size and about 1000 grams of this material was thoroughly mixed with 1000 grams of 10 days old cattle dung (1:1 ratio). After mixing, it was poured into plastic bins. After 10 days when temperature came down to ambient level then 10-10 clitellate worms of each species (E. eugeniae and Eisenia foetida) were transferred on vermicomposting bin. These bins were regularly watered during the period of study to maintain moisture of 60± 1 %. Three replications have been maintained till the granular appearance was not seen.

2.4. Collection of Vermicompost Samples for Analysis

Samples of vermicompost were collected from experimental bins after regular interval of time. Collect samples was allowed to air dry and stored in freeze at 4 to 8ºC ±1ºC till the completion of experiment (Nagar et a.,2018).

2.5. Measurement of Physical Parameters

During vermicomposting of both green and senescence leaf litters, collected compost sample was analyzed by a variety of physical and chemical factors.

1) **pH: It was determined with the help of pH meter according to the method of Rebollido et.al. (2008).**
2) **Temperature: It was measured by put in of thermometer vertically into vermicomposting bins at different depth (Alidadi, 2005; Adegunloye et. al., 2007).**
3) **Moisture percentage: It was measured by keeping weighted compost (5.0 gm) into hot air oven at 105ºC for 24 hrs, Next day dry weight taken and deducted from initial weight (Shouche et al.,2011).**
4) **Reduction of biomass: It was measured by scale. This was done after interval of 24 hours throughout the complete process (Nagar, 2017).**
5) **Total organic Carbon (TOC): It was measured by Walkey and Black chromic acid wet oxidation method (Jackson,1973).**
6) **Total Nitrogen (TN): It was measured by the modified Micro-Kjeldhal method (Umbreit et al., 1974).**

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Table 1: Changes in physical factors of Black plum leaf litter's during Vermicomposting.

S. No.	Collected sample	pH			Temp. (ºC)			Moisture			Biomass reduction			TOC (± 0.1)			TN (± 0.1)		
		GLL	SLL	CD	GLL	SLL	CD	GLL	SLL	CD	GLL	SLL	CD	GLL	SLL	CD	GLL	SLL	CD
1	1st week	5.6	5.6	8.5	33.3	33.6	38.5	68.80	49.21	60.35	28.46	28.59	14.84	46.12	45.12	28.12	1.05	0.85	0.65
2	2nd week	6.00	6.1	8.4	30.8	32.2	35.4	69.79	60.43	61.37	24.33	25.43	12.78	44.23	43.25	24.12	1.12	0.92	0.68
3	3rd Week	6.4	6.6	8.3	28.4	30.3	33.8	71.33	61.50	62.95	21.29	23.29	11.11	39.15	38.15	23.45	1.15	0.98	0.72
4	4th Week	7.3	6.9	8.2	27.7	29.7	32.5	73.43	63.83	63.83	19.87	20.74	10.68	37.65	36.98	22.48	1.19	1.02	0.78
5	5th week	7.4	7.00	8.2	25.9	27.5	29.9	75.11	64.77	64.69	17.39	19.31	10.34	34.25	34.02	21.78	1.20	1.10	0.79
6	6th week	7.5	7.2	8.1	24.4	26.6	27.5	76.69	65.66	64.89	15.42	18.23	9.72	31.12	30.45	20.18	1.24	1.14	0.82
7	7th week	7.7	7.3	8.1	23.6	25.4	25.5	77.83	66.83	65.65	14.63	16.84	8.74	28.15	27.76	19.48	1.25	1.15	0.89
8	8th week	7.8	7.6	8.00	22.8	23.6	24.7	78.57	67.86	66.28	13.68	15.57	7.95	26.35	25.47	18.45	1.27	1.18	0.98
9	09th week	7.9	7.7	8.00	22.5	22.6	22.9	79.83	69.32	66.35	11.49	13.83	6.17	24.12	23.85	16.98	1.29	1.20	1.02
10	10th week	7.9	7.8	-----	21.6	21.4	-----	79.86	70.32	------	10.63	11.25	-----	21.78	20.45	15.55	1.35	1.22	1.09
11	11th week	8.00	8.00	-----	19.7	20.7	-----	80.34	70.69	------	9.75	10.58	-----	19.18	18.45	14.32	1.45	1.24	1.12
12	12th week	8.1	8.00	-----	19.4	20.2	-----	80.69	71.32	------	9.19	9.23	-----	16.12	15.64	12.35	1.57	1.25	1.15
13	13th week	8.2	8.1	-----	18.5	19.6	-----	81.84	72.62	------	8.55	8.62	-----	16.05	15.45	12.12	1.58	1.26	1.20

Note: GLL= Green leaf litter, SLL= Senescence leaf litter, CD = Cattle dung, Temp = Temperature, TOC = Total organic carbon, TN= Total Nitrogen

3. Result and Discussion

Result obtained shows that (Figure no.1) at initial phase pH of both green leaf litter (GLL) and senesces leaf litter (SLL) was record acidic (5.6) which turn neutral range after four weeks. At the end of Vermicomposting process pH was set at alkaline range (8.2-8.4). Result also explored that pH of GLL showed more alkaline than SLL. The pH variation in control (100 % cattle dung) also recorded and found more alkaline (8.4) at beginning phase of vermicomposting but later at the end phase their alkaline nature turn down and final pH set at 8.0. The similar finding was also recorded in vermicomposting of different bioorganic waste viz. Floral waste (Shouche et.al.,2011); Eucalyptus leaf litter (Nagar et.al.,2017); Sandal wood leaf litter (Nagar et.al.,2018) . Basic composition of any type of biological materials shows presence of simple organic compound which is acidic in nature. Such compound reflects the pH during initial phase. When vermicomposting process begins, due to microbial fermentation more acids and CO2 added to the compound which also adjoin the acidification of organic waste, as a result final pH detect in more acidic range (Haimi and Huhta, 1987; Elvira et.al. 1998). Organic acid which formed during metabolism, get exhaust after synthesis. Their consumption thrashing the presence of acidic contributor as a result pH starts shift from acidic to neutral phase. Along with carbon compound, nitrogen compound also found in biological waste. Such compound is act as secondary choice for microorganisms which utilize after consuming of carbon compound. When nitrogenous compound metabolized then ammonium ion is generate which turn pH towards alkaline (Cuevas et al., 1988).

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
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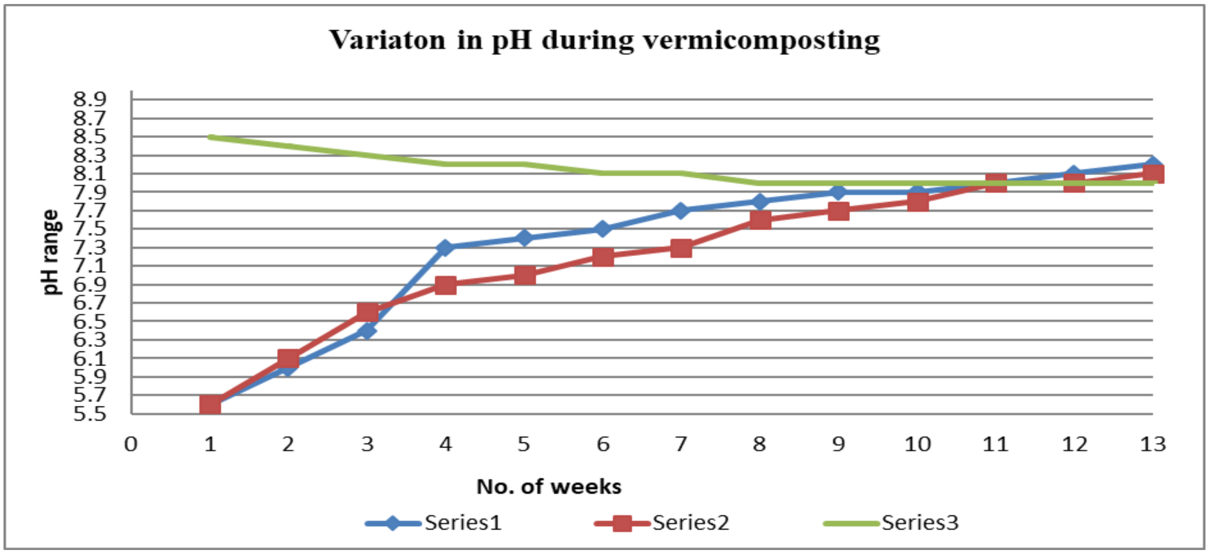

Figure 1: Measurement of pH during vermicomposting of leaf litter waste.
Note: Series 1: Green leaf litter (GLL), Series 2: Senescence Leaf litter (SLL), Series 3: Cattle dung (CD)

Result also stated that during Vermicomposting of both GLL and SLL organic waste, temperature recorded in changeable form which depicted in fig. no.2. It was higher at beginning phase of vermicomposting while gradually down till final stage. There were 14.5± 1ºC temperature difference recorded in between initial and final stage of vermicomposting process of both GLL and SLL composting mixture. At the end of process temperature were recorded 18.5 & 19.6±1ºC respectively in GLL and SLL. In case of control (100 % cattle dung), the highest temperature was recorded 38.5± 1ºC which turn down up to the level of 22.9± 1ºC. It was also noticed that in SLL composting mixture more temperature was recorded than GLL mixture but their temperature was lower than control (100 % cattle dung). There were several researchers cited in their research to elevation of temperature during the composting phase (Nagar, et al., 2018a; 2018 b; Lefebvre et al. 2000).At the initial level when composting set in motion the native microorganisms begin exploiting the organic materials for available carbon, nitrogen and other nutrients. Such stage called as mesophilic stage (Lugtenberg et al.,2009)17. As the process prolong, the temperature start to boost due to the heat generated by microbial metabolism. At this point the growth of mesophilic microorganisms are restrained by the high temperature and then thermophilic microorganisms set as very active position. This position not maintained for long time and soon after shifted to mesophilic phase. At the end of phase mineralization and humification occurs, and this phase is known as maturity stage (Gomez et al. 2007).

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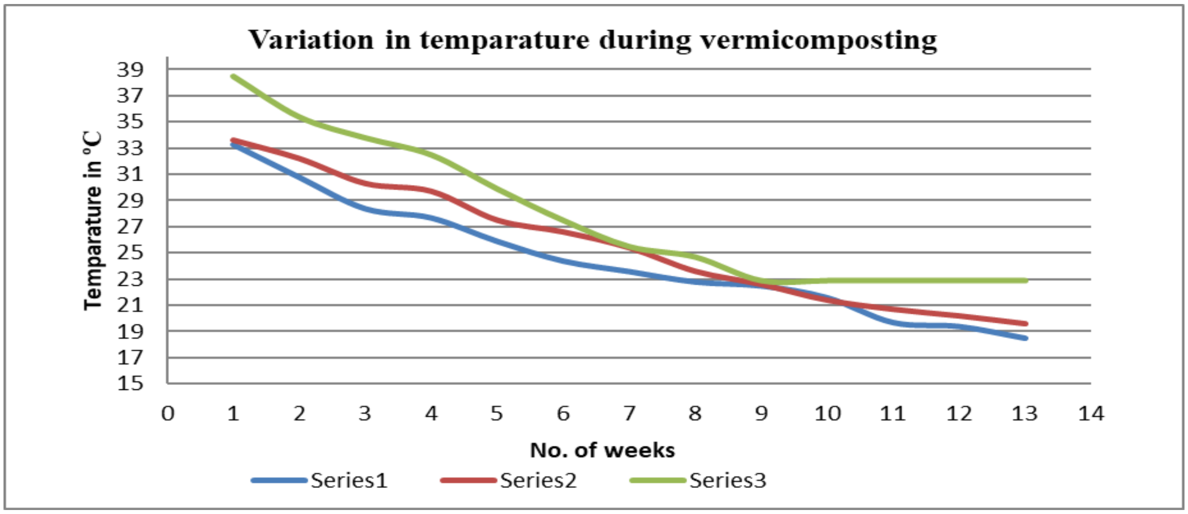

Figure 2: Measurement of temperature during vermicomposting of leaf litter waste.
Note: Series 1: Green leaf litter (GLL), Series 2: Senescence Leaf litter (SLL), Series 3: Cattle dung (CD)

During vermicomposting moisture content of the leaf litter was also measured. It has found that at initial phase GLL mixture content more moisture level (68.8 %) then SLL mixture (49.2 %) while the moisture level of cattle dung was recorded 60.3%. In order to maintain adequate moisture level in mixture, water was added after regular interval of time. During the course of process GLL mixture retain more moisture level than SLL. The requirement of addition of water in mixture was more in initial phase due to loss of water in the form of vapour. This loss was occurred due to generation of metabolic heat (Pirti,1978). While in later condition metabolic heat reduces due to exhausting of organic matter (Lefebvre ,2000; Yoshida &Rowe,2003). It has also found that water loss more frequently occur in first two weeks than it gradually slow down. Our result was concordance with result of solid waste and food waste composting done by Suler-Finstein (1977) and Sundberg (2003).

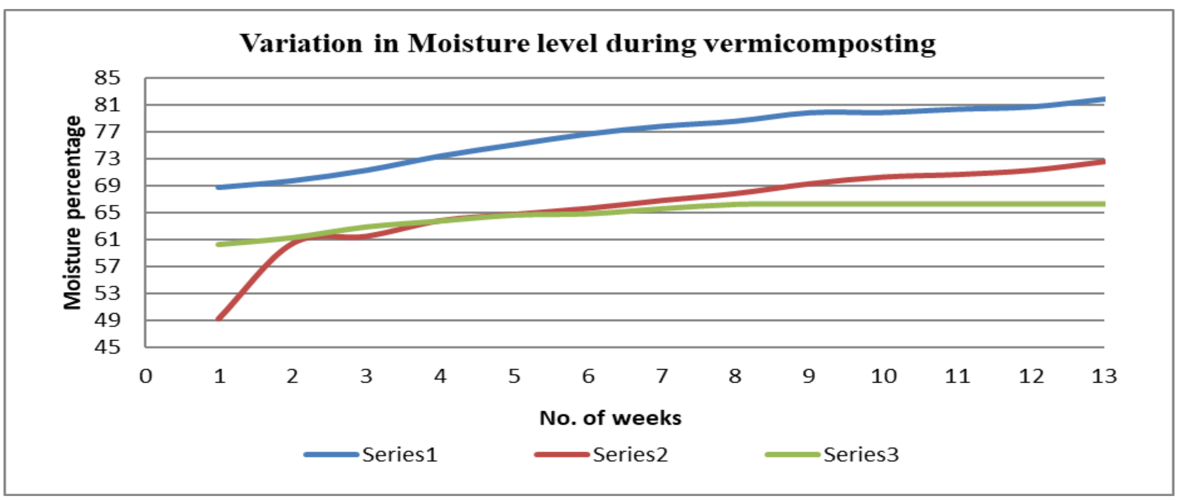

Figure 3: Measurement of Moisture percentage during vermicomposting of leaf litter waste.
Note: Series 1: Green leaf litter (GLL), Series 2: Senescence Leaf litter (SLL), Series 3: Cattle dung (CD)

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During the study, depletion of biomass of both GLL and SLL vermicomposting mixtures were also measured which shown in fig. no. 4. It was noticed that preliminary height of GLL and SLL were recorded 28.4 & 28.5± 1cm while in cattle dung it was recorded 14.8 ± 1 cm. The height of both leaf waste gradually decreased during the decomposition and finally it was set at the height of 8.5±1 cm while 6.0±1 cm in cattle dung Based on the result obtain it was found that during decomposition process, in both GLL and SLL 70 % height of waste and 57 % height of cattle dung were reduced. Our result compare with finding of Chaudhuri et.al. (2000) worked on kitchen waste and found same outcome. Leaf litter consists of water as well as organic compound viz. carbohydrate, protein etc. which make them bulky. During the vermicomposting, microorganisms and earthworm digest complex material into simplest form, resulting generation of heat and gas. Such heat converts water into vapour. Such loss act as causes for diminish the height of biomass (Lee,1985; Gosh et al.,1999).

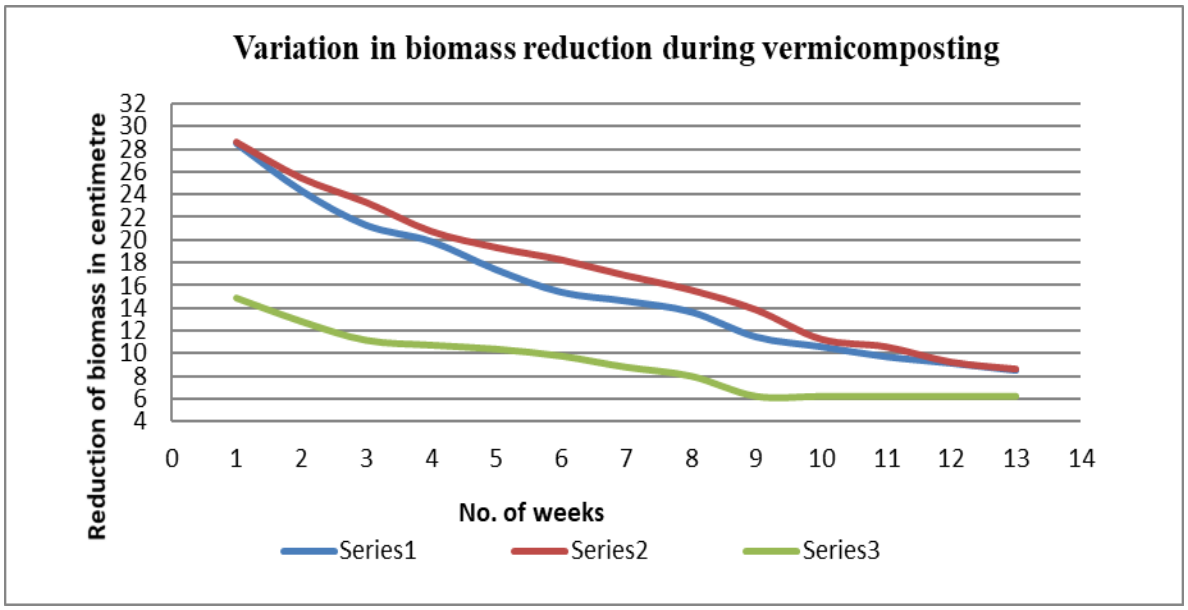

Figure 4: Measurement of biomass reduction during vermicomposting of leaf litter waste.
Note: Series 1: Green leaf litter (GLL), Series 2: Senescence Leaf litter (SLL), Series 3: Cattle dung (CD)

Total organic carbon (TOC) was also measured during process of vermicomposting. Obtained data revealed that GLL contained more TOC (46.12 %) than SLL (45.12%) as compared to 100 % cattle dung (28 %) at inauguration phase. Result also explore that during vermicomposting 65 % depletion took place in GLL waste while 63 % depletion took place in SLL as compaired to cattle dung (56 %) (Fig 5). It has to be supposed because cattle dung obtained after absorption of digested food in the alimentary canal of cattle. Therefore, it contains less concentration of total organic compound. In case of GLL Vermicomposting mixture, contains raw material in excessive quantity therefore it has more total carbon then 100% cattle dung. In case of SLL Vermicomposting waste, because complex organic substance such as cellulose, hemicelluloses and lignin found which decompose gradually therefore TOC remain at the end of process. It has also found that organic compound mineralizes gradually throughout the stage of composting (APHA, 1992)

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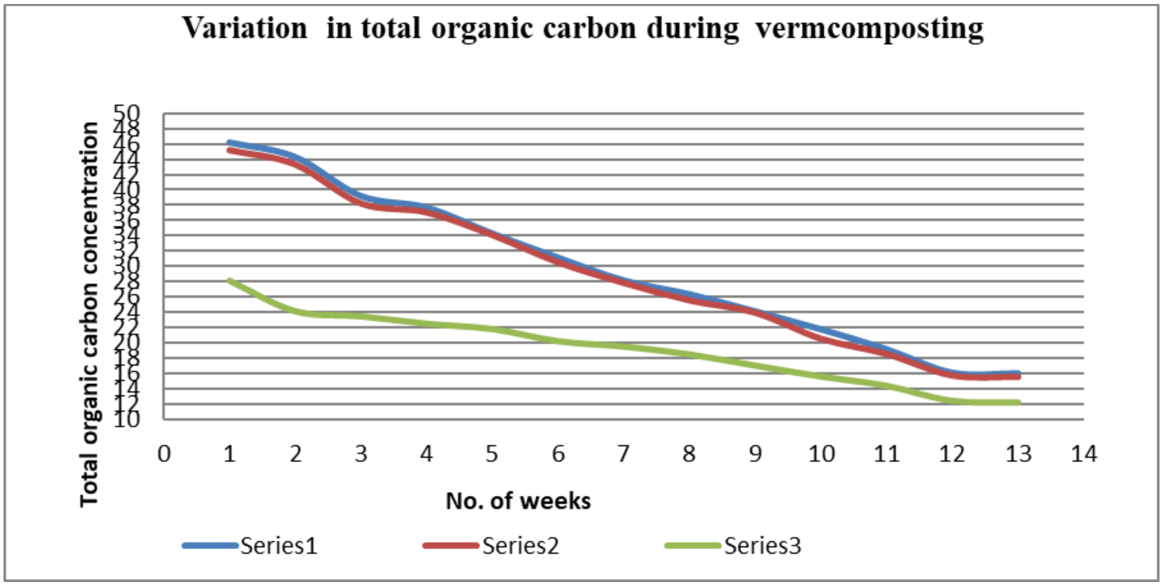

Figure 5: Measurement of Total organic carbon during vermicomposting of leaf litter waste. Note: Series 1: Green leaf litter (GLL), Series 2: Senescence Leaf litter (SLL), Series 3: Cattle dung (CD)

The measured value of total Kjeldhal nitrogen during the Vermicomposting process is depicted in Fig. 6. There was increase in total N contents in GLL, SLL and 100 % cattle dung. The total N content in GLL and SLL vermicompost mixture was measured 1.05 % ±0.1 and 0.85 % ±0.1 respectively while 0.65 %±0.1 recorded in 100 % cattle dung at first week. After 13th week it was reached at 1.58 % ±0.1, 1.26 %±0.1 and 1.20 % ±0.1 respectively. The fortification of nitrogen content during Vermicomposting affected by depends upon the verity of microbial populations and composition of organic wastes. Free living nitrogen fixer Microorganisms assimilates atmospheric nitrogen into useable form (Bhati et al.,2017). During Vermicomposting, earthworm also contribute in increasing the level of nitrogen in the form of mucus and excretory material (Bernal et al.,2009; Atiyeh et al.,2000).

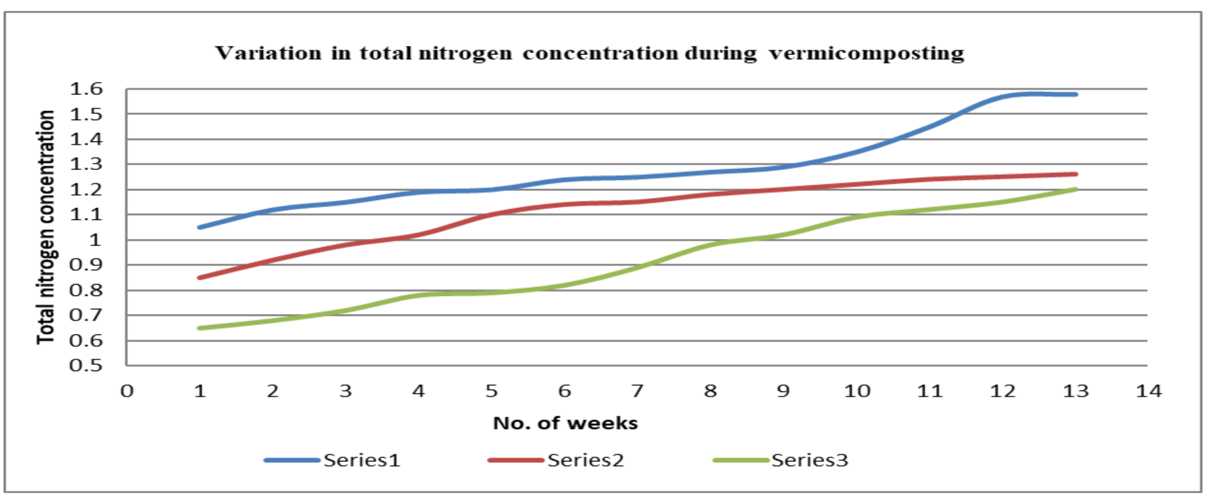

Figure 6: Measurement of Total nitrogen during vermicomposting of leaf litter waste. Note: Series 1: Green leaf litter (GLL), Series 2: Senescence Leaf litter (SLL), Series 3: Cattle dung (CD)

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4. Conclusions and Recommendations

Vermicomposting is no doubt a technique for conversion of organic waste into nutrient rich product called vermicompost. The outcome of present study has elaborated how different organic waste utilized through composting technique to get finished valuable product. Every set up of vermicomposting require optimum provision for survival and growth of earthworm. In present study we got some information regarding the physical factors viz. pH, temperature, moisture content and biomass reduction rate which infer the changes during entire period of vermicomposting. With this study we can get better our information that what factors should be keeps in mind to do vermicomposting of leaf litter. Chemical study also suggested that how carbon and nitrogen content changed during process and at what concentration we get at the end of process.

Acknowledgment

We are thankful to Principal, Govt. Madhav Science College for providing permission for conducting vermicomposting of leaf waste. The authors also wish to express their warm gratitude to the Department of Botany, Biotechnology & Microbiology for accompanying laboratory experiment.

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*Corresponding author.
E-mail address: bhati_p212@ yahoo.co.in