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Influence of amount of red worm (*Eisenia foetida*) on the organic matter degradation during vermicomposting of cattle manure

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Abstract

This study aimed to understand the degradation pattern of organic substances through different amount of red worms during vermicomposting of cattle manure. For this purpose, an experiment was conducted with three treatments e.g., T_1 (vermicomposting of 25 kg cowdung using 50 g of red worms), T_2 (vermicomposting of 25 kg cowdung using 100 g of red worms) and T_3 (vermicomposting of 25 kg cowdung using 150 g of red worms) with 3 replications. Parameters studied were dry matter (DM), organic matter (OM), ash, organic carbon (OC), total nitrogen (TN), crude fiber (CF), carbon nitrogen ratio (C/N) and pH at different days of intervals. Results showed that the amount of red worms has a significant influence on the quality of the final vermicompost. The highest DM content was observed in T_3 and the lowest DM content was observed in T_1 after 45 days of composting. There were significant ($p<0.001$) higher reduction rate of OM, OC and CF were found in T_3 compared to T_1 and T_2 and the differences were also significant ($p<0.001$) among days intervals over 45 days of experimental period. TN content gradually increases with the increase of time. There was significant ($P<0.05$) difference in TN alteration among treatments along with time intervals. There was significant differences ($P<0.001$) in C/N among treatments and a gradual increment of C/N was found with the advancement of the vermicomposting. There were a little changes in pH of all the treatments but those treatments were not followed a trend during the total experimental period. Finally, it may be concluded that organic matter degradation rate is faster in T_3 compared to T_1 and T_2. These might be indicated that amount of red worms are an important factors of OM decomposition or digestion during vermicomposting period.

Keywords: cattle manure, red worm, vermicompost, organic matter degradation

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Introduction

Livestock plays an important role in the economy of Bangladesh (Rahman *et al*., 1997, 1998 and 1999; Begum *et al*., 2007). It has a large livestock population including 3rd largest position of cattle in Asia and a large number of poultry which are contributing for milk, meat and eggs for 160 million people in Bangladesh (Baset *et al*., 2003). Besides the livestock products and by-products, huge amounts of wastes produced daily from these large number of livestock and poultry population. It is estimated that approximately 156 million tons of cattle manure and 4.5 million tons of poultry manure are produced in Bangladesh every year (Modak *et al*., 2019). These manures and wastes are a potential hazard to the environment due to the release of nitrate and phosphate to the streams, ponds and ground water; as well as ammonia, hydrogen sulphide gas in the air (Ashan *et al*., 2013 and 2014; Lee *et al*., 2009; Won *et al*., 2016) due to inappropriate disposal of waste (Rahman *et al*., 2008: Sarker *et al*., 2009 and 2018; Roy *et al*., 2013). Livestock manure can also contain a number of pathogens and other materials that are a potential risk to public health (Runge *et al*., 2007). Livestock manure, a solid waste resulting from livestock rearing, is being explored as feedstock for compost, vermicompost or biogas production. Livestock manure biomass is also a massive source of GHGs emission that enhances the global warming. Huge amount of poultry, cattle and goat manure has produced daily that is a significant source of environmental pollution in our country. The increase in population causes an increase in the quantity and type of urban and rural wastes. Such wastes release undesirable pollutants to the environment and pollute the surrounding areas. As far as rural wastes are concerned, there are enormous quantities of organic materials that are not utilized. Vermicomposting technology is a fast growing one with its pollution free, cost effective and efficient nature. Since 2,350 years ago Aristotle was reported, vermiculture is basically the

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science of breeding and raising earthworms. It defines the thrilling potential for waste reduction and fertilizer production. Vermicomposting is a simple environment-friendly technology that supports sustainable agriculture and waste management programs. It involves physical and biochemical action of earthworms in converting organic materials (usually wastes) into two useful products- the earthworm biomass and high quality organic fertilizer, the vermicompost. The efficiency of vermicomposting may be measured by the worm number and/or biomass and the vermicompost produced. To achieve high efficiency one of the keys is selection of proper substrate which is composed of bedding material and food source for the worms. Organic matter intake of red is about 75% of their body weight per day. Earthworms weigh about 0.2 g and require oxygen and water, both exchanged through their skin. OM is digested by the digestive juice available in the worm's gut when OM passes through its gut; additionally it is mineralized into ammonium and other plant nutrients. The grinding effect of its gizzard and the effect of its gut muscle movement result in the formation of casts (Garg *et al*., 2008).

Vermicomposting involves physical and biochemical action of earthworms in converting organic materials (usually wastes) into two useful products- the earthworm biomass and high quality organic soil conditioner, the vermicompost. The biochemical action is the breakdown of the substrate by beneficial microorganisms in the earthworm's gut. The goals of vermicomposting are to continually increase the number and weight of worms and to convert the substrate material into vermicompost in the shortest time and highest recovery as possible. With the useful products, vermicomposting can be engaged in by farmers as source of extra income. Vermicompost is rich in NKP (nitrogen 2-3%, potassium 1.85- 2.25% and phosphorus 1.55-2.25%), micronutrients and beneficial soil microbes and also contain plant growth hormones and enzymes. It is scientifically proving as miracle growth promoter and also plant protector from pests and diseases. Vermicompost retains nutrients for long time and while the conventional compost fails to deliver the required amount of macro and micronutrients including the vital NKP to plants in shorter time, the vermicompost does. Vermicompost contains plant hormones like auxin and gibberellins and enzymes which believed to stimulate plant growth and discourage plant pathogens. It improves the fertility and water holding capacity of the soil. It also enriches the soil with useful microorganisms which add different enzymes like phosphatases and cellulases to the soil. Vermicompost enhances germination, plant growth and thus overall crop yield (Gajalakshmi and Abbasi, 2004). Vermicompost is an eco-friendly natural fertilizer prepared from biodegradable organic wastes and is free from chemical inputs. It does not have any adverse effect on soil, plants and environment. Vermicompost contains most nutrients in plant available form such as nitrates, phosphates and exchangeable calcium and soluble potassium (Edwards *et al*., 1998). It promotes better root growth and nutrient absorption. It improves nutrient status of soil both macro and micro-nutrients. It is the potential way of recycling waste to valuable fertilizer. Some small scale industry can be developed in our country in rural areas that may help to create some employment opportunity. Compost can also provide a steady supply of nutrients to growing plants and increase the soil ability to retain essential minerals (Stevenson, 1994; Alam *et al*., 2013; Rahman *et al*., 2013).

It was, therefore, imperative to convert the cow manure by using of different amount of worms to generate in huge amount to produce good quality of vermicompost with a minimum period of time. Taking this into consideration, the present study was carried out with the following objectives:

i. To compare the efficiency of organic matter (OM) degradation among different level of worms used for vermicomposting.
ii. To know the efficiencies of earthworm activity during OM decomposition of cow manure with different amount of worms used.
iii. To know the chemical composition of vermicompost produced from cattle manure.

Materials and Methods

Experiment site and duration

The experiment was done in two phases: The first phase was the preparation of vermicompost from cattle manure and the second phase was laboratory analysis of vermicompost. Preparation of vermicompost was carried out at the Goat, Sheep and Horse Farm under the Department of Animal Science, Bangladesh Agricultural University, Mymensingh. The vermicomposting period was 45 days started from 28 January 2019 to 12 March 2019. The laboratory analysis of the vermicompost was carried out at laboratory in the Department of Animal Science, Bangladesh Agricultural University, Mymensingh.

Design of the experiment

To fulfill the objectives of the study and experiment was conducted with three different treatments e.g., vermicomposting of 25 kg cowdung using 50 g of red worms (T_I), vermicomposting of 25 kg cowdung using 100 g of worms (T_2) and vermicomposting of 25 kg cowdung using 150 g of red worms (T_3). There were three replications in each treatment to minimize the experimental errors. The samples were collected from vermicomposting pits at 0, 15, 30 and 45 days for proximate analysis.

Collection of red worms, raw materials and preparation of vermicomposting pit

There is a rich breeding stock of red worms in the farm section of waste recycle and renewable energy laboratory of Department of Animal Science, BAU. Cattle also available in goat and sheep farm under the Department of Animal Science, BAU. Red worm was collected and stored in appropriate breeding condition previously before setting the vermicomposting operation. Nine concrete pits, locally called as chari was used to prepare vermicompost. Three treatments were replicated three times each and a total of nine vermicomposting pits were used in this experiment. On preparation of vermicompost no filler materials was used. The chari/pits were semicircular in shape having a diameter of 0.5 meter and a height of 0.3 meter. The pots were kept still and secure condition under a tin-shed building having secured perimeters. Approximately 25 kg manure was collected for each chari/pit and a total of 225 kg cowdung were utilized for this experiment.

Vermicomposting process

Initially, all the 9 chari/pits/composting beds were cleaned and 25 kg raw manure was added to each chari and then different amount of red worms (T_1, T_2 and T_3 with 3 replications) were added on the surface of the vermicomposting pit. Previously, the manure was sorted to remove unwanted materials or plastic/inorganic material with organic waste. Approximately 75-80% moisture was maintained initially for easy movement of the red worms. All bins/chari were placed in the vermicomposting shed to prevent from sun or rain. All the chari/pits were placed with a fixed distance to avoid closeness. It is not recommended to let the pit too dry or over water as it killed the worms. Moisture level was checked in the composting bin on a regular basis.

Figure 1: Releasing red worm (*Eisenia foetida*) on the top of the cowdung pile

Collection of samples for laboratory analysis

First sample was collected from the raw cowdung on the 1st day of experiment. Nearly about half month of interval from starting this process, samples were collected from the vermicomposting pits/chari. Every fortnightly, 9 samples (3 treatments with 3 replications) were collected to analyze the said parameters. Vermicompost samples were analyzed in the laboratory of Animal Science, BAU. The collected samples were stored in refrigerator in Animal Science laboratory for further analysis. Second collection was after 15thdays and the third sample collection was on the 30th day of vermicomposting process and the final sample was collected on the 45th day of composting process. After each collection of samples were analyzed to determine DM, OM, Ash, OC, TN, CF, C/N ratio and pH after collection of each replicated sample.

Statistical analysis

The data were analyzed for in a Completely Randomized Design (CRD) through SAS statistical software. Significant mean values were tested with DMRT (Duncan's Multiple Range Test). All data were presented as Mean±SEM.

Results and Discussion

Proximate components of cow dung

The proximate components of cow dung, vermicomposting were estimated in this experiment for DM, OM, Ash, OC, TN, CF, C/N, and pH. Organic matter degradation of vermicomposting at 1st to 45th day at different days intervals are discussed here. Average percentage of DM, OM, Ash, OC, TN, CF, C/N, and pH were 20.99, 16.12, 2.67, 11.32, 1.26, 14.43, 16.26 and 8.31, respectively in T_1. Very closer values were found in T_2 and T_3 in all parameters (Table 1).

Dry matter (DM) alteration during vermicomposting

There were changes in DM content at different intervals of 45 days period (Table 2). In the all three treatments of vermicomposting, DM content gradually increased with the increasing of time. The highest DM content was observed in T_3 (vermicomposting of 25 kg cow dung using 150 g of red worms. There was significant ($p<0.01$) difference in DM alteration among treatments and significant ($p<0.01$) difference in DM alteration among day intervals over 45 days period. However, the alteration of DM was related significantly ($p>0.05$) between treatments and day intervals. Higher amount of worms indicate higher number of red worms that move through the vermicomposting pit. Vermicomposting operations were done at aerobic condition in an open place which was favorable for moisture loss might be cause of higher DM content. Similar same result was observed by Adely and kits (1983) who reported that dry matter content increased with the increasing of time period.

Table 1: Chemical composition of raw cattle manure

Parameters	T_1	T_2	T_3
DM	20.99±0.61	20.79±0.76	21.05±0.51
OM	16.12 ±0.78	16.21±0.67	16.19±0.66
Ash	2.67 ±0.16	2.81 ±0.24	2.76 ±0.19
OC	11.32 ± 0.30	11.25 ± 0.10	11.28 ± 0.45
TN	1.26 ± 0.08	1.18± 0.09	1.32± 0.08
CF	14.43 ±0.05	14.32±0.06	15.23 ±0.06
C/N	16.26 ± 0.14	16.33 ± 0.10	16.36 ± 0.19
pH	8.31 ± 0.09	8.45± 0.08	8.27± 0.09

T_1: vermicomposting of 25 kg cow dung using 50 g of red worms; T_2: vermicomposting of 25 kg cow dung using 100 g of red worms; T_3: vermicomposting of 25 kg cowdung using 150 g of red worms.

Table 2: Status of DM during vermicomposting of cattle manure with different amount of worms

Time interval in Days (DI)	Treatments (Mean±SD)			Overall Mean±SD	Level of significance		
	T_1	T_2	T_3		Treat	DI	T*DI
0	20.99^b±0.61	20.79^b±0.76	21.05^a±0.51	20.94±0.63	**	**	*
15	21.13^c±0.88	22.08^b±0.06	23.43^a±0.82	22.21±0.58			
30	23.71^c±0.55	24.41^b±0.56	25.43^a±0.46	24.51±0.52			
45	25.36^c±1.20	26.71^b±0.21	28.46^a±0.90	28.84±0.69			

T_1: vermicomposting of 25 kg cow dung using 50 g of red worms; T_2: vermicomposting of 25 kg cow dung using 100 g of red worms; T_3: vermicomposting of 25 kg cowdung using 150 g of red worms. Figures followed by same letter (s) within a row do not differ statistically. ** means significant at 1% level of probability; *means significant at 5% level of probability.

Table 3: Periodic change in OM during vermicomposting of cattle manure with different amount of worms

Time interval in Days (DI)	Treatments (Mean±SD)			Overall Mean±SD	Level of significance		
	T_1	T_2	T_3		Treat	DI	T*DI
0	16.12^a±0.78	16.21^a±0.67	16.19^a±0.66	16.17±0.70	**	**	NS
15	16.21^b±0.98	15.49^a±0.95	14.92^a±0.70	15.54±0.65			
30	14.08^c±0.71	13.32^b±0.27	12.26^a±0.40	13.22±0.91			
45	12.40^c±1.29	11.68^b±0.15	10.51^a±0.81	11.53±0.95			

T_1: vermicomposting of 25 kg cow dung using 50 g of red worms; T_2: vermicomposting of 25 kg cow dung using 100 g of red worms; T_3: vermicomposting of 25 kg cowdung using 150 g of red worms. Figures followed by same letter (s) within a row do not differ statistically. NS means not significant; ** means significant at 1% level of probability; *means significant at 5% level of probability.

Organic matter (OM) alteration during vermicomposting

The study found a gradually decrease in OM content in all of the treatments of vermicomposting over 45 days period of composting. In all case of vermicomposting, the highest OM content was observed at 0 day and the lowest OM was observed at 45 days of vermicomposting (Table 3). Red worms engulf the OM of manure and digest them with their digestive enzymes. There was significant ($p<0.01$) difference in OM alteration among treatments and significant ($p<0.01$) difference alteration among day intervals over 45 days period. However, the alteration of OM did not vary significantly ($p>0.05$) between treatments and day intervals. Earthworm utilized the OM for their body physiology and the excreta are called vermicompost. The lowest OM was found in T_3 compared to T_2 and T_1. Vermicost contains microorganisms, hormones, enzymes, inorganic minerals and organic matter in a form available to plants. Based on the physical, chemical and biological characteristics, vermicompost have considerable commercial potential in the horticultural industry as container media for growing vegetable and bedding plant. Aalok et al. (2009) reported that the species of earthworms can consume organic residuals very rapidly and fragment them into much finer particles by passing them through a grinding gizzard, an organ that all earthworms possess.

Ash alteration during vermicomposting

The study found a little decrease in ash content in all of the treatments of vermicomposting over 45 days period of composting (Table 4). The lowest ash content was observed in T_1 (Vermicomposting of 25 kg cow dung using 50 g of red worms) after 45 days of composting. There was significant ($p<0.01$) difference in ash alteration among treatments and significant ($p<0.01$) difference alteration among days intervals over 45 days period. The results also shown that ash contents has a significant relation ($P<0.05$) between treatment and days interval. The similar result was found by Jacob et al. (1997) who observed that the ash content decrease due to increasing composting period.

Table 4: Periodic changes in ash during vermicomposting of cattle manure with different amount of worms

Time interval in Days (DI)	Treatments (Mean±SD)			Overall Mean±SD	Level of significance		
	T_1	T_2	T_3		Treat	DI	T*DI
0	2.67^c±0.16	2.81^a±0.24	2.76^b±0.19	2.74±0.19	**	**	*
15	2.52^a±0.11	2.48^a±0.04	2.31^b±0.11	2.43±0.08			
30	2.43^a±0.15	2.10^b±0.04	2.16^b±0.07	2.23±0.09			
45	1.95^b±0.08	2.03^a±0.06	1.84^c±0.09	1.97±0.07			

T_1: vermicomposting of 25 kg cow dung using 50 g of red worms; T_2: vermicomposting of 25 kg cow dung using 100 g of red worms; T_3: vermicomposting of 25 kg cowdung using 150 g of red worms. Figures followed by same letter (s) within a row do not differ statistically. ** means significant at 1% level of probability; *means significant at 5% level of probability.

Table 5: Periodic changes in OC during vermicomposting of cattle manure with different amount of worms

Time interval in Days (DI)	Treatments (Mean±SD)			Overall Mean±SD	Level of significance		
	T_1	T_2	T_3		Treat	DI	T*DI
0	11.32^a±0.31	11.25^a±0.10	11.28^a±0.45	11.28±0.28	**	**	*
15	11.06^a±0.11	10.13^b±0.05	9.96^c±0.41	10.38±0.59			
30	10.63^a±0.16	9.53^b±0.15	8.17^c±0.22	9.44±1.23			
45	9.44^a±0.11	8.41^b±0.09	6.91^c±0.47	8.25±1.27			

T_1: vermicomposting of 25 kg cow dung using 50 g of red worms; T_2: vermicomposting of 25 kg cow dung using 100 g of red worms; T_3: vermicomposting of 25 kg cowdung using 150 g of red worms. Figures followed by same letter (s) within a row do not differ statistically. NS means not significant; ** means significant at 1% level of probability; *means significant at 5% level of probability.

Organic carbon (OC) alteration during vermicomposting

There were changes in OC content at different intervals of 45 days period (Table 5). In the all three treatments of vermicomposting, OC content gradually decreases with the increasing of time. The highest OC contents were found at 0 days and lowest OC contents were found at 45 days after composting. There was significant ($p<0.01$) difference in OC alteration among treatments and significant ($p<0.01$) difference in OC alteration among day intervals over 45 days period. But the alteration of OC was vary significantly ($p<0.05$) between treatments and day intervals. The data revealed that total organic carbon decreased with days of vermicomposting. Organic carbon content decreases at the end of the vermicomposting because of the organic carbon consumption by earthworm, the transformation in CO_2 by respiratory activity and formation of humic fraction which gives place to the mature vermicompost, i.e., oxidation of carbon to carbon dioxide during decomposition (Pattnaik and Reddy, 2009). Yadav and Garg (2013) reported that the vermiprocessing significantly increased nitrogen, phosphorous, and potassium contents of the mixtures. However, a decrease in pH, organic carbon, and C/N ratio was observed after vermiprocessing. Mistry et al. (2015), Tripathi and Bhardwaj (2004), Punde and Ganorkar (2012) reported that significant decline in OC content after worms inoculation.

Total nitrogen (TN) alteration during vermicomposting

There were changes in TN content at different intervals of 45 days period (Table 6). In the all three treatments of vermicomposting, TN content gradually increases with the increase of time. There was significant ($P<0.05$) difference in TN alteration among treatments and significant ($P<0.05$) difference alteration among day intervals over 45 days period and there was also significant ($P<0.05$) relation between treatments and days intervals. The enhancement of total N in vermicompost was probably due to mineralization of the organic matter containing proteins (Bansal and Kapoor, 2000 and Kaushik and Garg, 2003); total amount of N present in the feed materials (Suthar 2007).

Table 6: Periodic changes in TN during vermicomposting of cattle manure with different amount of worms

Time interval in Days (DI)	Treatments (Mean±SD)			Overall Mean±SD	Level of significance		
	T_1	T_2	T_3		Treat	DI	T*DI
0	1.26^b±0.08	1.18^c±0.09	1.32^a±0.08	1.25 ±0.08	*	*	*
15	1.61^a±0.04	1.34^c±0.05	1.40^b±0.08	1.45±0.05			
30	1.82^a±0.08	1.56^b±0.06	1.85^a±0.09	1.74±0.07			
45	1.84^b±0.06	1.68^b±0.81	1.95^a±0.07	1.82±0.13			

T_1: vermicomposting of 25 kg cow dung using 50 g of red worms; T_2: vermicomposting of 25 kg cow dung using 100 g of red worms; T_3: vermicomposting of 25 kg cowdung using 150 g of red worms. Figures followed by same letter (s) within a row do not differ statistically. ** means significant at 1% level of probability; *means significant at 5% level of probability.

Earthworms can boost the nitrogen levels of the substrate during digestion in their gut adding their nitrogenous excretory products, mucus, body fluid, enzymes, and even through the decaying dead tissues of worms in vermicomposting subsystem. Similar result also found by Krishan *et al*. (2014), Tripathi and Bhardwaj (2004) and Sitaramlaxmi *et al*., (2013). Yadav and Garg (2013) reported that, the vermin processing significantly increased nitrogen, phosphorous, and potassium contents of the mixtures. However, a decrease in pH, organic carbon, and C/N ratio was observed after vermicomposting. The heavy metal contents in the vermicomposts were higher than the initial values but within permissible limits.

Crude fiber (CF) alteration during vermicomposting

Initially, the CF content was higher in all treatments of cattle manure but it was found a decreasing trend with ongoing of the time period (Table 7). Comparative higher CF (15.23%) was found in T_3 at the starting day but 45 days it was found a much lower CF in T_3 (1.66%) compared to T_2 (2.72%) and T_1 (3.38%). The result was due to the worm's subsequent ingestion and digestion of fiber in vermicomposting. The study found that CF degradation rate is faster in vermicomposting with cow dung using 150 g of worms than other levels of worm used. There was significant ($p<0.01$) difference in CF alteration among treatments and significant ($p<0.01$) difference alteration among day intervals over 45 days period. The results also shown that CF contents has a significant relation ($P<.01$) between treatments and day intervals. A clear decreasing trend in CF at all treatments indicated that earth worms are very efficient in CF decomposition or digestion during vermicomposting.

Table 7: Periodic changes in CF during vermicomposting of cattle manure with different amount of worms

Time interval in Days (DI)	Treatments (Mean±SD)			Overall Mean±SD	Level of significance		
	T_1	T_2	T_3		Treat	DI	T*DI
0	14.43^b±0.05	14.32^b±0.06	15.23^a±0.06	14.66±0.496	**	**	**
15	11.16^a±0.05	10.94^b±0.06	9.86^c±0.16	10.65±0.69			
30	7.99^a±0.07	6.82^b±0.07	5.56^c±0.12	6.79±1.22			
45	3.38^a±0.10	2.72^b±0.08	1.66^c±0.06	2.59±0.87			

T_1: vermicomposting of 25 kg cow dung using 50 g of red worms; T_2: vermicomposting of 25 kg cow dung using 100 g of red worms; T_3: vermicomposting of 25 kg cowdung using 150 g of red worms. Figures followed by same letter (s) within a row do not differ statistically. ** means significant at 1% level of probability.

Table 8: Periodic changes in C:N during vermicomposting of cattle manure with different amount of worms

Time interval in Days (DI)	Treatments (Mean±SD)			Overall Mean±SD	Level of significance		
	T_1	T_2	T_3		Treat	DI	T*DI
0	16.26^b±0.13	16.33^a±0.10	16.36^a±0.19	16.31±0.14	**	**	NS
15	19.98^a±0.24	19.87^b±0.45	19.69^c±0.25	19.84±0.23			
30	18.40^a±0.13	17.81^b±0.47	17.23^c±0.21	17.81±0.27			
45	18.26^a±0.13	17.97^b±0.28	16.91^c±0.15	17.71±0.18			

T_1: vermicomposting of 25 kg cow dung using 50 g of red worms; T_2: vermicomposting of 25 kg cow dung using 100 g of red worms; T_3: vermicomposting of 25 kg cowdung using 150 g of red worms. Figures followed by same letter (s) within a row do not differ statistically. NS means not significant; ** means significant at 1% level of probability.

Table 9: Periodic changes in pH during vermicomposting of cattle manure with different amount of worms

Time interval in Days (DI)	Treatments (Mean±SD)			Overall Mean±SD	Level of significance		
	T_1	T_2	T_3		Treat	DI	T*DI
0	8.31^b±0.09	8.45^a±0.08	8.27^c±0.09	8.34±0.08	*	**	NS
15	8.14^b±0.05	8.76^a±0.05	8.72^a±0.03	8.70±0.04			
30	9.07^a±0.11	9.17^a±0.07	8.23^b±0.05	8.82±0.07			
45	9.01^a±0.05	9.10^a±0.05	8.47^b±0.20	8.76±0.10			

T_1: vermicomposting of 25 kg cow dung using 50 g of red worms; T_2, vermicomposting of 25 kg cow dung using 100 g of red worms; T_3, vermicomposting of 25 kg cowdung using 150 g of red worms. Figures followed by same letter (s) within a row do not differ statistically. NS means not significant; ** means significant at 1% level of probability, *means significant at 5% level of probability.

C:N alteration during vermicomposting

There were changes in C:N content at different intervals of 45 days period (Table 8). In the all three treatments of vermicomposting, C:N content gradually increases with the increase of time. There was significant ($P<0.01$) difference in C:N alteration among treatments and a significant ($P<0.01$) difference alteration among day intervals over 45 days period but there was no significant ($P>0.05$) relation between treatments and day intervals. An increasing trend of C:N is might be due to decreasing of OM and increasing of TN as a result of physiological activities of the earthworm. The similar trend was found by Kaushik and Garg (2003) reported that vermicomposting resulted in significant increment in C:N and TN. Similar trend in C:N ratio could be observed in the present investigation.

pH alteration during vermicomposting

Over the time a little alters in pH of all the treatments but those treatments were not followed a trend (Table 9). Initially, higher pH was found in T_2 (vermicomposting of 25 kg cow dung using 100 g of red worms) but after 45 days the highest pH was observed in T_3 (vermicomposting of 25 kg cow dung using 150 g of red worms). There was significant ($P<0.05$) difference in pH alteration among treatments and a significant ($P<0.01$) difference alteration among days intervals over 45 days period but there was no significant different between treatments and day intervals. The reduction in pH in the final products could also have been due to the production of CO_2 and organic acids by microbial activity during the process of bio-conversion of the different substrates in the beds (Haimi and Huhta, 1986). Nath *et al*. (2009) also reported that vermicomposting results in significant decreased in pH, total organic carbon and electrical conductivity.

Conclusion

Vermicomposting activity involves in breeding and reproduction of earthworm. Amount of red worms indicate the number of worms that would be involved in decomposition of organic matter in the vermicomposting pit. Significant OM degradation was occurred in all the three treatment groups, but better result was found in T_3, means that 150 g red worm efficiently degraded 25 kg cow dung within 45 days. Higher amount of red worm shows the better decomposition of OM in this experiment. It may be concluded that organic matter degradation rate was faster during vermicomposting of 25 kg cattle manure which treated with 150 g of red worms than that of 100 g and 50 g of red worm respectively.

Conflict of interest

There is no conflict of interest among the authors to declare.

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