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Production of vermiculture and compost as influenced by different animal excreta and decomposition periods

S.S. BAGHEL, U.S. MISHRA[1], B. SACHIDANAND AND S.B. AGARWAL[2]

Department of Soil Science & Agril. ChemistryJawaharlal Nehru Krishi Vishwa Vidyalya, Jabalpur-482004 (MP) India

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ABSTRACT

In order to assess the efficiency of red worm to convert various animal wastes (cow dung, buffalo dung, horse dung, goat excreta and pig excreta) under different partial decomposition periods (20,30 and 40 days), a pot experiment was concluded in a factorial randomized design at research farm, JNKVV, Jabalpur (M.P.) during 2015-16. Results of study revealed that out of various animal excreta, cow dung followed by buffalo and pig excreta proved to be better with respect to weight gain by earthworm, However, horse dung proved to be slightly better to cow and buffalo dung in terms of counts, production and recovery percentage. The increase in partial decomposition period markedly increased the efficiency of earthworms to convert waste in to vermicompost as well as the growth of worms.

Key words: Animal excreta, vermicompost, partial decomposition period, Eisenia fetida .

INTRODUCTION

Animal wastes are considered as an important source of manure for crop to supplement organic matter and improve soil conditions; Animal wastes also create environmental pollution. India has the world's largest bovine population and recorded 294 million, including cows, bullocks, buffaloes and calves. Interestingly, the piggery and poultry industry has grown substantially in the last two decades in an organized way. Eutrophication from animal waste runoff has been linked to the out break of toxic microorganisms which caused destruction and disease of fish and wild life population. The fertilizer values of animal waste are not being fully utilized resulting in loss of potential nutrients. The animal wastes are also creating odour problems (Garg *et.al.,* 2005). Under present situation, it becomes very essential to protect environment from future degradation. It needs to develop appropriate technologies for recycling various organic wastes and to harness energy and minimize the environmental stress (Nagavallemma *et al.* 2004 & Parak *et al.* 2004). Vermicompsting is an appropriate technique for effective and efficient recycling of animal wastes like cattle dung, poultry manure, piggery excreta, crop residues, municipal solid waste, effluents from agro-industries viz., dairy, tannery, pulp and paper mill, distillery, etc. by using earthworms. (Giraddi 2008 and Sharma, 2014) It has been estimated that one tonne of moist organic matter can be converted into 300 kg of compost by earthworms. Earthworms are important biological creature helps in nature to maintain nutrient flow from one system to another and also minimize the environmental degradation (Roy *et al. 2006*).This ability is being exploited now a days for the production of vermicompost. However, its efficiency is affected by five types of waste and its degradation status. Thus, for the safe disposal and proper utilization of animal excreta, it needs to be converted into valuable compost through vermiculture biotechnology. Keeping the above facts in view, the study on production of vermiculture and vermicompost production efficiency of red worm (*Eisenia fetida*) as influenced by different animal excreta and partial decomposition periods was conducted.

MATERIALS AND METHODS

A pot experiment was designed to evaluate the practical potential and factors which affect the vermistablization. The study was made at livestock research farm JNKVV, Jabalpur (MP) during 2014-15. The animal excreta were collected from the livestock research farm, Jabalpur.Young non-clitellates. Specimens of *Eisenia fetida,* weighing 250 g (live weight) were randomly picked from several stock cultures maintained in the laboratory with cow dung as culturing materials. Fresh waste of five different animals, viz, cow dung (Cd), buffalo dung (Bd),

[2]*College of Agriculture, MGCGVV Chitrakoot, Distt.- Satna (MP) India*
[4]*Krishi Vigyan Kendra , Jabalpur (MP) India*
Corresponding author Email- drssb75@gmail.com, ssbatic@rediffmail.com

horse dung (Hd), goat excreta(Ge) and pig excreta (Pe) were collected from different animal sheds located in live stock farm. The dung consisted of a mixture of faeces and urine without any bedding material. The major characteristics of animal waste are given in Table 1.

Table1: Initial physico-chemical characteristics of animal wastes

Animal waste	Moisture content (%)	pH (1:10)	EC (dSm^{-1})
Cow dung	84.0	8.5	2.18
Buffalo dung	85.0	8.3	2.19
Horse dung	72.6	8.2	2.08
Goat excreta	66.2	8.9	2.42
Pig excreta	74.2	8.1	2.03

All the samples were taken on dry weight basis for biological studies and chemical analysis that was obtained by oven drying the known quantities of material at 110^{o} C.

A uniform weight of each excreta, on dry weight basis (12 kg dry weight /pot) were used and put in the experimental pot, The waste were turned manually everyday during partial decomposition period completed as per treatments in order to eliminate volatile toxic gases. As soon as partial decomposition period completed as per the treatments, non-clitellated hatchling, each weighing 250 g were inoculated in each containers and kept in dark at room temperature of 25 ± 1^{0}C. Biomass gain, multiplication, production and recovery were recorded at final collection of vermicompost as per the treatments. The feed in the container was turned out and earthworms were separated from the feed by hand sorting then they were counted and weighted after washing with fresh water. The pH and electrical conductivity (EC) were determined using a double distilled water suspension of each waste in the ratio of 1:10 (w/v) that had been agitated mechanically for 30 min and filtered through Whatman No.1 filter paper.

RESULTS AND DISCUSSION

Weight of earthworms

Data (Table2) reveal that weight of worms singnificantly varied due to animal excreta and partial decomposition periods. Higher weight (533.11g) of worms was recorded in cow dung closely followed by buffalo (530.37) and pig excreta (552.48). Whereas development of worms significantly reduced under goat excreta (268.60) and deteriorate the weight (248.59) in short periods of partial decomposition (20 days) even than the initial weight of (250g). The weight of earthworms significantly increased with the use of comparatively more decomposed matter which is measured by the period given for partial decomposition to the excreta. The maximum weight (482.34 g) was recorded under 40 days which was significantly higher over 30 and 20 days however, the differences between 20 and 30 were not significant.

Table 2: Weight gained by earthworms (g) under partial decomposition periods and animal excreta used as substrata

Weight of worms (g) at final stage					weight gained by earthworms(g)			
Animal excreta	Partial Decomposition period (days)			Mean	Partial Decomposition period (days)			Mean
	20	30	40		20	30	40	
Cd	528.02	533.12	538.20	533.11	278.02	283.12	288.20	283.11
Bd	526.32	529.38	535.41	530.37	276.32	279.38	285.41	280.37
Ge	248.59	275.00	282.22	268.60	218.59	235.11	217.78	223.82
Hd	492.86	508.83	513.40	505.03	242.86	258.83	263.40	255.03
Pe	514.51	531.78	552.48	532.92	274.51	281.78	292.48	282.92
Mean	408.06	475.62	484.34		258.06	267.64	269.45	
CD (5%)	AE 21.58	PDP 11.9	AE X PDP 32.70					

The weight of earthworms increased with the increase in duration for partial decomposition in all substrata, but rate of increase in weight of earthworms was different with various substrata. Its rate was study in dung of cow, buffalo and horse with enhancing the duration of partial decomposition from 20 to 40 days but increase in rate of weight was rapid under goat and pig excreta between 30 to 40 days of partial decomposition.

Weight gained by Earthworms

The maximum weight accumulated in the worms which were put in the dung of cow (283.11g) followed by 282.92 g and 280.37 g in pig excreta and buffalo dung, respectively. Where as, the lowest weight gain of 255.03 g was noted with horse dung but goat excreta showed the negative performance with respect to weigh accumulation in body of worms. The weight gain increased as the period of partial decomposition increased. It is interesting to note that weight gained by earthworms was in negative direction in goat excreta, but with the increase in period of partial decomposition increased the weight of worms and showed positive response at 30 and 40 days of partial decomposition. However, overall performance with goat excreta was in negative side. Thus, above findings clearly showed that the goat excreta alone proved to be a unfit for the growth and survivability of earthworms. There fore, it has to be decomposed for more than periods of 40 days before release of earthworms. It is remarkable to note that the gain of weight by the earthworm was maximum with dung of buffalo and cow followed by pig excreta, horse dung and goat excreta which could be garnered from the multiplication ratio of 3.33,3.23,2.85, 2.78 and 1.45 respectively. It means weight of earthworms collected from the vermicomposts of buffalo and cow dung increased 3 fold, respectively, over the weight of earthworms initially inoculated. But in case of gain of weight by the earthworms in goat excreta were negligible, which could be observed from their multiplication ratio of 1.45.

Table 3: Multiplication of worms as affected by various treatments

Animal excreta	Counts of earthworm at final stage				Multiplication rate of earthworm			
	Partial Decomposition period (days)			Mean	Partial Decomposition period (days)			Mean
	20	30	40		20	30	40	
Cd	803	874	890	855.6	2.87	3.17	3.66	3.23
Bd	855	914	930	899.6	2.95	3.17	3.87	3.33
Ge	301	314	329	314.6	1.44	1.45	1.48	1.45
Hd	920	939	970	943.0	2.64	2.82	2.89	2.78
Pe	705	725	756	728.6	2.70	2.92	2.94	2.85
Mean	716.8	753.2	775		2.52	2.70	2.96	
CD (5%)	AE 46.0	PDP 29.0	AEX PDP NS					

Count of Earthworms

The number of earthworms was counted after the completion of process in different excreta and partial decomposition periods (Table 3). The maximum count (943) of earthworms was noted under horse dung closely followed by buffalo (899.6) and cow dung (855.6). Whereas, the minimum count (314.6) was observed with excreta of goat. However, pig excreta produced significantly lowest counts of worms to buffalo and horse dung. The counts of worms significantly increased with the increasing the duration of partial decomposition and maximum number (775) was noted under 40 days of partial decomposition, which was significantly superior over both of 20 days but at par to 30 days. The lowest counts (716.8) were noted under 20 days of partial decomposition.

The weight gained by the earthworms was minimum with 20 days partial decomposition periods as 30 and 40 days, Consequently, the multiplication ratio of earthworms was 2.52, 2.70 and 2.96 with 20, 30 and 40 day of partial decomposition periods, respectively. The unfavorable nature of goat excreta coupled with its high temperature and pH during the periods of partial decomposition resulted into minimum multiplication ratio of earthworms, owing to poor growth and development. Similarly, high temperature in these substrata except to cow dung and buffalo dung at 20 days after partial decomposition resulted in to less multiplication ratio of earthworms, which gradually improved by increasing in their partial decomposition periods. Similar results were reported by San Thy, 2001 who observed that it was not good to apply earthworm culture in fresh substrata. Not only weight of earthworms reduced due to their poor growth in goat excreta which were partially decomposed for 20 days, but population of earthworms drastically reduced due to poor multiplication of earthworms. Obviously, cow dung and buffalo dung were most suitable

substrata for rapid growth and development of earthworm and thus it led to record maximum number of earthworms with maximum weight gain. Excreta of horse dung were the next suitable substrata with regard to growth and development of earthworms. Moreover, goat excreta found to be unsuitable for growth and development of earthworms. Several workers have emphasized similar opinions regarding growth and development of earthworms (Biradar *et al.* 2000 and Gupta, 2004).

Table 4: Production and recovery of vermicompost (%) as affected by various treatments

Production of vermicompost (kg)					Recovery of vermicompost (%)			
Animal excreta	Partial Decomposition period (days)			Mean	Partial Decomposition period (days)			Mean
	20	30	40		20	30	40	
Cd	7.58	7.94	8.56	8.02	63.16	66.16	71.30	66.87
Bd	7.83	7.52	8.29	7.88	65.20	62.52	69.00	65.57
Ge	5.38	5.59	6.16	5.71	44.80	46.58	51.33	47.57
Hd	7.63	7.97	8.93	8.17	63.50	66.40	74.44	68.11
Pe	6.82	7.90	8.33	7.68	56.83	65.58	69.41	63.94
Mean	7.04	7.38	8.05		59.09	61.44	67.09	
CD (5%)	0.67	0.55	1.22					

Production of Vermicomposts

Different animal excreta in equal quantity (12 kg) were taken an the basis of dry weight and were allowed to aerobic decomposition for the periods of 20, 30 and 40 days, and then earthworms were released uniformly at the rate of 250 g by weight in each treatments, separately. Maximum quantity of vermicompost was produced from horse dung (8.17 kg), which was comparable to those obtained from cow dung (8.02 kg) and buffalo dung (7.88 kg). Thus, the recovery of vermicompost was 68.11, 66.87, 65.57, 63.94 and 47.57 percent presentednin descending order of horse, cow, buffalo, pig and goat excreta, respectively. The accumulation of dry matter in the from of vermicompsts mostly depeonds upon the type of substrata used for composting and activities of earthworms existed during composting (Gunadi and Edwards, 2003). As discussed earlier that both pH and temperature were comparatively unfavorable for the growth and development of earthworms in goat and pig excreta, which might have restricted the activities of earthworms and slow down the degradation of substrata owing to less recovery of vermicomposting. Similar results were observed by Beetz (2001) and Thang (2003). It is remarkable that vermicompost production was minimum (7.04 kg) after 20 days period of partial decompose due to poor activities of earthworms because of relatively high temperature immediately after inoculation of earthworms. The production of vermicompost significantly increased as 7.38 and 8.05 kg by increasing partial decomposition periods for 30 and 40 days, respectively. It is interesting to note that vermicompost production increased by 14.2 % with 40 days period of partial decomposition over 20 days pre decomposition periods. The pH and temperature of substrata were unfavorable for the activities of earthworms, when they were released for composting after 20 days of partial decomposition periods, but these parameters of substrata become more congenial after 40 days partial decomposition periods, particularly, with horse and dung of cow and buffalo. The interactions between different animal wastes used for composting and their partial decomposition periods were also significant. Through the increase in vermicompost production from various substrata was at higher rate by enhancing the duration of goat excreta, the values were more in case of horse, cow dung and buffalo. Thus, it could be stated that horse, cow and buffalo dung were most suitable substrata for vermicomposting over rest of the two substrata goat and pig excreta. The activities of earthworms and other microbes were slow with these substrata even allowing them for longer periods under aerobic conditions due to unfavorable conditions. Hence, these substrata proved to be unsuitable for vermicomposting. Alternatively, horse, cow dung and buffalo dung were found suitable for composting while allowing them for pre decomposition even for short periods of 20 days. These results are in close conformably with the findings of Singh *et al.* (2010). Who reported that the activity of earthworms depends upon the suitability of substrata.

The increase in the recovery of vermicomposts as 59.09, 61.44 and 67.09% due to partial decomposition periods of 20, 30, 40 days, respectively, gave an idea to belief that rearing of earthworms for vermicomposting after completion of 40 days periods for aerobic decomposition could be the most effective teaching of vermicomposting. These results are in close conformity with the findings of several workers (Gunadi and Edwards, 2003; Sarangthem *et al.*, 2004 and Garg *et al.*, 2005).

Recovery of Vermicompost

Recovery percent of vermicompost was computed and presented in (Table 3) reveal that recovery of vermicomposts differed markedly among the various animal excreta used for vermicomposting. Horse dung possessed maximum recovery of vermicomposts (68.11%) followed by cow dung (66.87%), buffalo (65.57%), pig excreta (63.94%) and goat excreta in descending order (47.57%) Likewise, the shortest duration of partial decomposition (20 days) led to minimize the recovery of vermicompost (59.09%), which orderly increased with the increase in periods of decomposition as 30 (61.44%) and 40 days (67.09%), respectively.Based on two years study it could be concluded that the substrata of horse dung, cow and buffalo dung with respect to counts of worms and product on of vermicompost, similarly recovery percent of vermicompost was also higher with horse dung.Whereas goat excreta seems to be unfit. The partial decomposition with in waste in days interval of 7 days proved to be superior over preceded lower interval this the partial decomposition either of due substrata for 40 days is an ideal combination for the vermicompost production.

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