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Effect of feeding materials on yield and quality of vermicompost and multiplication of *Eisenia fetida* in sub-tropical environment of Nepal

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Abstract

The effects of different feeding materials on yield and quality of vermicompost and multiplication of Eisenia fetida was studied under shade house condition in sub-tropical environment of Chitwan, Nepal. Five different types of feeding material: cabbage, banana stem, grasses, cow dung and mixture of these feeding materials at the ratio of 1:1:1:1 were assessed. One thousand adult earthworms were fed in plastic worm bins. Duration required for the digestion of the feeding materials into vermicompost, amount and quality of vermicompost, the multiplication of earthworm, time required for the maturation of different types of vermicompost were recorded. Total NPK content of vermicompost produced from different feeding materials varied significantly with the types of feeding materials. Total NPK content was significantly higher in cow dung (2.1:1.7:1.9) followed by mixture of feeding materials (1.8:1.4:1.5), cabbage (1.6:1.2:1.4) grasses (1.4:1.1:1.) and banana stem (1.3:0.8:0.6). Vermicompost maturity was significantly earlier in cow dung feed (101 days), followed by mixture, banana stem, grasses, and cabbage. Multiplication of worm was highest in cow dung followed by mixture, banana stem, grasses and least in cabbage.

Key words: Eisenia fetida; feeding material; vermicompost; multiplication; yield

INTRODUCTION

Environmental problem has been a major problem all over the world due to rapid urbanization, industrialization and the continued uses of chemical fertilizers and pesticides. In the past four decades the use of fertilizers has increased significantly. Continued yet increasing use of chemical fertilizers has resulted into degradation of soil quality and fertility which eventually reduced the crop productivity. At least partial substitution of chemical fertilizers by organic or biofertilizers would enhance soil health for sustainability of crop productivity.

Large amount of organic residues and wastes are available in agricultural for recycling into organic fertilizers. Traditional method of composting takes about 5-6 months in composting of raw materials. More recently, vermi-culture technology has been developed to convert organic wastes into good quality compost within 70-90 days. This technology has been used to recycle solid waste into organic manure for organic food production (Gandhi et al., 1997).

The earthworm particularly red worm *(Eisenia fetida)* is the most suitable species for vermicomposting and it is widely used for the vermicomposting in Nepal. *Eisenia fetida* has a wider tolerance for temperature than other species. It tolerates as high as 42^0C and as low as 5^0C. They feed on wide range

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of solid waste and consume organic material equal to their body weight per day (Reinecke *et al*.1992). The growth and reproduction of *Eisenia fetida* is also faster than other species of earthworms (Saini *et al.,* 2010). However, types or nature of feeding materials influences the growth of earthworms, duration for digestion and nutrient content of vermicompost. Multiplication and digestion is faster in fruit waste than that of vegetable (Yami and Shrestha 2005, and Pant and Yami, 2008). Similarly, the organic carbon and NPK contents of vermicompost prepared from agriculture and industrial wastes also vary significantly (Kale 1998).

A variety of feeding materials for vermicomposting are locally available in Nepal. However, evaluation of locally available materials for feeding preference of worms, and quantity and quality of vermicompost has not been reported in Nepal. Hence this study aimed to assess the preferential foraging of earthworm and determine the nutrient contents and yields of vermicompost from different feeding materials.

MATERIALS AND METHOD

The research was conducted during August - October 2012 in shade house located at the premises of Everest VermiTech Centre Nepal in Bharatpur, Chitwan. Experimental site is situated at 27^{o} 37' north latitude and 84^{o} 25' east longitude with elevation of 256 masl. The research consists of five treatments with three replications in complete randomized design. The treatments used were cabbage, banana stems left after fruit harvest, grasses, cow-dung and a mixture of cabbage, banana stems, grasses and cow-dung in the ratio of 1:1:1:1 ratio. Three tray worm bins ($42\times42\times35cm^3$) was used as a container for feeding the earthworms. Half kilogram chopped rice straw was kept at the bottom of the first tray as bedding materials in all treatment and 0.5 kg FYM was added above the bedding materials for starter. One thousand earthworms weighing 200 gm were introduced in first tray of the bin. Two kg feeding material was fed to the worms at the interval of one week for twelve weeks. Once the earthworms end up with feeding materials of the first tray than they move upward into the 2nd and eventually 3rd tray than the first tray was harvested. Before harvesting vermicompost, watering was withheld. Adult earthworms were separated from vermicompost by the help of sieve. Population count, time taken for digestion of feeding materials for vermicast and NPK content were recorded and statistically analyzed by using the ANOVA procedure described by Gomez and Gomez (1984). When the F-test indicated statistical significance at the P = 0.01 and P = 0.05 level, the Duncan's Multiple Range Test was used to compare the difference of the means.

RESULTS AND DISCUSSION

Nutrient content of vermicompost

The result showed that the total nitrogen, phosphorus and potassium content of vermicompost produced from different feeding materials varied significantly with the types of feeding materials (Table 1). Total Nitrogen, Phosphorus and Potassium contents were recorded the highest in cow dung (2.1: 1.7: 1.9) followed by mixed feed type (1.8:1.4:1.5), cabbage (1.6: 1.23: 1.45), grasses (1.40: 1.10: 1.20) respectively. The lowest nutrient content was obtained in vermicompost produced from banana stem (1.30: 0.80: 0.60). Cow-dung being a nutritional rich substrate contained highest amount of NPK. Initial content of NPK was higher in cow-dung than that of other substrates. The present findings is in agreement with that of Manna et al. (1997), who found nitrogen content of vermicompost to be high in nutrient rich feeding materials.

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The similar trend was also found by Suthar (2007) in the process of vermicomposting. Ismail 1997 reported that suitable material for vermicomposting can be nitrogen rich material like dung of cow, buffalo or other agro waste. The increment observed in the concentration of N, P and K would probably be due to mineralization of organic wastes.

Table1. Change in nutrient contents (total nitrogen, phosphorus and potassium) of vermicompost with the type of feeding materials fed to *Eisenia fetida,* (Chitwan, 2012).

Type of feeding materials	Nutrient content (%)		
	Total nitrogen	Total phosphorous	Total potassium
Cabbage	1.6^{c}	1.23^{c}	1.45^{b}
Banana stem	1.30^{d}	0.80^{d}	0.60^{d}
Grasses	1.40^{d}	1.10^{c}	1.20^{c}
Cow dung	2.1^{a}	1.7^{a}	1.9^{a}
Mixture	1.8^{b}	1.4^{b}	1.5^{b}
LSD	*0.01458***	*0.145***	*0.1458***
SEM (±)	*0.045*	*0.045*	*0.045*
CV (%)	*4.96*	*6.23*	*5.86*
Grand mean	*1.596*	*1.247*	*1.324*

Kaushik and Garg (2003) stated that mineralization of organic matter containing proteins increases N content in vermicompost. Earthworms increase N content of the substrate during digestion in their gut adding their nitrogenous excretory products, mucus, body fluid, enzymes and decaying dead tissues of worms (Suthar, 2007). Likewise, the worms during vermicomposting convert the insoluble P into soluble forms with the help of P solubilizing microbes through phosphatases present in the gut (Suthar and Singh, 2008).

NPK interrelationship in the vermicompost

The concentration of NPK in the vermicompost increased linearly in the order from the feed types of banana, grasses, cabbage, mixture and cow dong respectively (Figure 1). An increase in N content of vermicompost is also highly correlated with the increase in the P and K contents of the vermicompost. This data suggests that enhancement of NPK in vermicompost is parallel, hence, the NPK content of the vermicompost is balanced.

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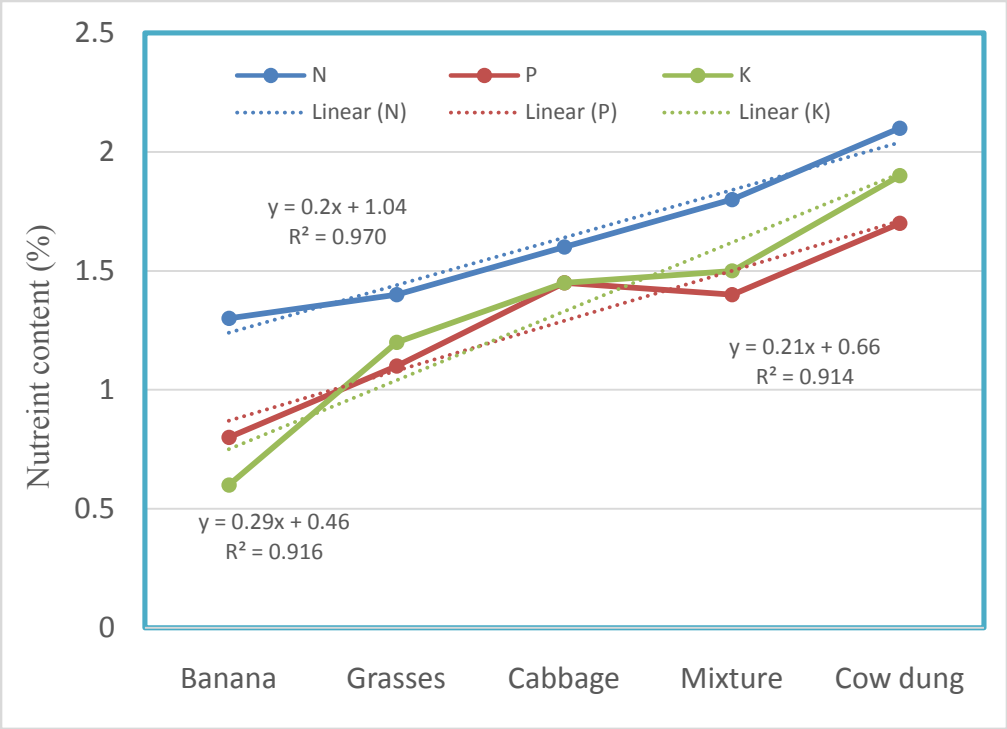

Figure 1. Changes in NPK content of vermicompost with different feeding materials fed to *Eisenia fetida* (Chitwan, 2012).

Multiplication of earthworms

Multiplication of earthworm among the treatments varied significantly with feeding materials. Earthworm densities significantly higher in cow dung (3854) which was followed by mixture of feeding materials (2789), banana stem (2545) and grasses (1655). High mortality was found in cabbage. Hence least earthworm density was recorded in cabbage feeding (552). This finding supported to the work of Garg et al., 2005, who found 26 times higher population in cow dung. Similar result was also reported by Siddique et al. (2005) who found cattle manures to be an excellent food source for earthworm. Similar study of Nauhauser *et al.(1980)* is in line with the present findings who observed that rate of biomass gain by *E. fetida* was dependent on population density and food type. The faster growth rate of earthworms in cow dung attributed to already digestible form with high nutrient content than other feeding materials,

The high mortality was found in cabbage which may be attributed to poor aerated condition for earthworm. The initial moisture content was higher in cabbage compared to other feeding materials which created too poor aeration for worm growth.

Time taken for vermicomposting preparation

The time taken for the digestion of feeding materials for the preparation of vermicompost varied significantly with feeding materials, which ranges from 101-118 days (Table 2). Maturity was earlier in cow dung feeding (101 days), followed by mixture of cow dung and other feeding materials (108 days). Time taken for banana stem was 112 days, for grass 117 days, and for cabbage 118 days. The shortest time

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taken in cow dung is attributed to partially decomposed nature of cow dung as feeding materials. The longest duration taken in cabbage may be attributed to low population of earthworm due to high mortality and similarly longer time taken to grass attributed to delayed decomposition of grasses.

Table 2. Days required for vermicomposting, earthworm population and vermicompost yield as influenced by different feeding materials fed to *Eisenia fetida,* (Chitwan, 2012).

Types of feeding materials	Time taken for VC(days)	Earthworm count per bin	Vermicompost yield (kg/bin)
Cabbage	118[a]	552[e]	2.40[d]
Banana stem	112[b]	2545[c]	4.70[c]
Grass	117[a]	1655[d]	5.40[b]
Cow dung	101[d]	3854[a]	6.5[a]
Mixture	108[c]	2789[b]	5.1[b]
LSD	1.03**	192.8**	0.43**
SEM (±)	0.34	59.12	0.14
CV (%)	0.53	4.45	4.96
Grand mean	111.27	2301.13	5.02

Yield of vermicompost

Vermicompost yield also varied significantly with type of feeding materials (Table 2). Yield was significantly higher in cow dung (6.5 kg), followed by grass (5.4 kg). Yield obtained from the grasses and mixture was at par. The lowest yield was recorded in cabbage (2.4 kg). It is very obvious that the multiplication of earthworms depends directly on quality and nutrient content of feeding materials fed to earthworms.

It is very obvious from the study that feeding materials is very critical for growth and development of worms, yield and nutrient contents of vermicompost and duration of vermi-composting. The partially decomposed feeding materials of high inherent nutrient content are suitable feeding materials for growth and development of earthworms, and improved yield of high quality of vermicompost production in short duration. The faster growth rate of earthworms leading to high population density reduces the time taken for composting and increases the vermicompost yield of high nutrient contents.

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