COMPOSTINGANDVERMICOMPOSTINGOF POULTRY LITTER USING *EISENIA FOETIDA* EARTHWORM SPECIES: A COMPARATIVE STUDY

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Introduction

Worldwide, poultry industries are growing rapidly and contributing towards addressing key national development goals as well as improving the standard of living of people through poverty alleviation and providing employment opportunities (Agblevor et al., 2010). Poultry litter is one of the waste produced in large amounts as a byproduct at poultry farm, reaching millions of tons annually (Daniel and Karmegam, 1999). According to Bhattarai (2012), the recent population status of poultry in Nepal is; 1.1 million broiler parents, ten thousands layer parents, 76 million commercial broilers and 8.3 million commercial layers which equals about 85.5 million poultry producing about 0.1 million metric ton manure per year. This huge quantity of poultry waste needs to be disposed of in a technically-feasible, environmentally-sound and economically-viable manner.

Poultry waste is highly organic in nature so its rapid decomposition is not possible. Furthermore, it contains greater concentration of nutrients as compared to manure from other large animals. However, it is not suitable for direct application into the field and research has been therefore directed to utilize poultry litter in different ways.

Vermicomposting is a simple biotechnological process of composting, to tackle the problem of safe disposal of waste as well as to release the most needed plant nutrients for sustainable productivity (Nagavallemma et al., 2004). Though the practice of vermiculture is at least a century old however, it is being received worldwide with diverse ecological objectives such as waste management, soil detoxification, and regeneration, organic and sustainable agriculture (Joshi, and Chauhan, 2006). Many researchers have reported the potentiality of Eisenia foetida for decomposition of different types of organic wastes viz. domestic as well as industrial waste resulted in increase in the yield of value added material (Grag et al., 2006). In this study, decomposition of poultry litters to assess the efficacy of Eisenia foetida effecive microorganism in composting poultry litters, and to evaluate the compost and vermicomposts thus obtained for the availability of C, N, P and K as plant nutrients.

Materials and Methods

Composting Materials

The poultry litters were collected from Pancharatna Poultry Farm, Chitwan, Nepal and analyzed in Agriculture Technology Centre, Pulchowk, Lalitpur, Nepal for its initial nutrient content. It was dried for 4 days and pre-composted for 15 days. E. foetida, one of the best known species for its feeding behaviour was procured from Organic Agriculture Farm, Fulbari, Chitwan.

Design of Experiment and Treatement Combination

The experiment was set up in compost beds made with bricks in a dimension of 1.36×0.5×0.12 m3 and floor of vermibeds were covered with plastic. To maintain humidity and aeration vermibeds were covered with wet gunny bags. The collected poultry litter were pre-digested for 15 days till all the litters were partially decomposed. The vermi-bed contained pre-digested poulty litters and maintained in triplicates for each treatments set up. 0.02 liter EM-Active/2 liter of water per bed, 20 kg poultry litter and 400 number/0.50 kg earthworms per beds introduced as treatments. The moisture content was maintained by sprinkling adequate amount of water, throughout the study period of 90 days.

Table 1. Treatment combination and their symbol name used in the experiment

Treatment number	Treatment Structure	Treatment name
1	Broiler cage litter (BCL) with earthworm (EW)	BCL/EW
2	Broiler cage litter (BCL) with effective microorganism (EM)	BCL/EM
3	Broiler deep litter (BDL) with earthworm (EW)	BDL/EW
4	Broiler deep litter (BDL) with effective microorganism (EM)	BDL/EM
5	Layer cage litter (LCL) with earthworm (EW)	LCL/EW
6	Layer cage litter (LCL) with effective microorganism (EM)	LCL/EM
7	Layer deep litter (LDL) with earthworm (EW)	LDL/EW
8	Layer deep litter (LDL) with effective microorganism (EM)	LDL/EM

Analytical Procedures

Physical Parameters

The pH was measured by 1:5 Water ratio.

Chemical Parameters

Organic carbon, total nitrogen, available organic phosphorus and potassium were determined as described in the references. All the above parameters were analyzed in the compost and vermicompost on the 90th day. The data obtained was represented as mean ± SEM ($p \leq 0.05$).

Results

Initail plant nutrient content like Carbon, Nitrogen, Phosphorus and Potassium were analyzed in ATC, Pulchowk Lalitpur, Nepal (Table-1). After 90 days of experimental period earthworm species E. Foiteda converted the pre-digested poultry litter into vermicompost and the vermicompost was dried directly in sunlight to separate and count the earthworms from the compost. Vermicompost thus obtained was subjected to physico-chemical analysis for the pH and for the plant nutrients like Carbon, Nitrogen, Phosphorus and Potassium (Table-2).

Table 1. Physico-chemical characteristics of raw poultry litter prior to vermicomposting

Poultry litters	Nitrogen (N) %	Phosphorous (P) %	Potash (K) %	Organic matter (OM) %	Moisture %	pH
BCL	1.37	0.75	1.00	48.26	62.18	7.50
BDL	1.54	0.75	1.00	52.36	37.00	7.65
LCL	2.03	0.90	1.50	55.42	51.10	7.60
LDL	1.32	0.72	1.30	35.36	10.52	7.35
Mean	1.56	0.78	1.20	47.85	40.20	7.52
±SE	0.16	0.04	0.12	4.41	11.15	0.06

Table 2. Effects of EW and EM on macronutrient (nitrogen, phosphorous and potassium) concentration of different poultry litters following vermicomposting and composting

Treatment	Nitrogen (N) %	Phosphorous (P) %	Potassium (K) %
BCL	2.1b	1.7a	1.7a
BDL	1.7c	0.9b	1.3b
LCL	2.5a	1.7a	1.7a
LDL	1.9b	1.4a	1.7a
±SEM	0.02	0.06	0.04
LSD FA	0.06	0.19	0.14
Earthworm	2.3a	1.7a	2.0a
EM	1.6b	1.1b	1.1b
LSD FB	0.01	0.04	0.03
Probability			
FA	<0.01	<0.01	<0.01
FB	<0.01	<0.01	<0.01
AxB	<0.01	<0.01	<0.01
CV %	2.7	11.3	7.7

Average of triplicate represented as Mean ± SEM ($p \leq 0.05$)

Table 3. Combination effects of EW and EM on macronutrient (NPK) concentration of different types of poultry litters following vermicomposting and composting

Main Factor	Sub Factor					
	Nitrogen (%)		Phosphorous (%)		Potassium (%)	
Litter type	EW	EM	EW	EM	EW	EM
BCL	2.3^{b}	1.7^{d}	2.0^{a}	1.2^{b}	2.0^{a}	1.1^{c}
BDL	1.5^{e}	1.7^{de}	0.8^{d}	0.9^{cd}	1.5^{b}	1.1^{c}
LCL	3.4^{a}	1.7^{d}	2.0^{a}	1.2^{b}	2.2^{a}	1.1^{c}
LDL	2.2^{c}	1.8^{d}	1.9^{c}	1.1^{bc}	2.1^{a}	1.1^{c}
SEM ±(AxB)	0.03		0.09		0.06	
$LSD_{(0.05)}$	0.09		0.27		0.21	

Average of triplicate represented as Mean ± SEM ($p \leq 0.05$)

Discussion

Composting and vermicomposting methods are widely used method of solid waste degredation and as more researchers and entrepreneurs conduct studies regarding the ability of the earthworms to process organic waste in to usable soil amendments (Riggle, 1998). Vermiculture is a mixed culture containing soil bacteria and earthworms which provides the use of natural bioreactor, the earthworm for cost effective and environmentally sound technology of waste management. The pre-digestion of poultry litter made the organic waste simpler for the earthworms to consume. The auto heating during pre-digestion also helps in digestion of waste, as the heat released during pre-digestion, enables the earthworms to breed successfully (Nagarathnam, 2000).

Physico-Chemical characterization of Vermicomposts

Physical Parameters

The pH of the compost and vermicompost is important, as the application of compost to the soil can alter the soil pH, which in turn affects the availability of nutrients to the plants. Worms can survive in a pH of 5-9. Vermicompost worked by worm and effective microorganisms and tolerated a pH range of 6.9-7.7, and both was suitable methods of solid wate disposal. Earthworms by passing through the soil and organic matter gradually make acid soil less acidic and alkaline soil less alkaline (Ndegwa, and Thompson, 2000).

Chemical Parameters

Vermicompost contained high concentrations of organic material, silt and clay and was also rich in many soil nutrients such as nitrogen, sulphur, potash, phosphorus, calcium, magnesium etc (Kalantari, 2010). The level of organic carbon in vermicompost worked by E. foetida contained $20.44 \pm 2.18\%$ which was significantly lower when compared to that of initial organic carbon content 27.75 ± 2.55 ($p \leq 0.05$) indicating higher rate of decomposition. The total nitrogen content was observed to be high (1.7-2.5%) in vermicompost of E. foetida as compared to EM composted (1.7-1.8%) poultry litters resulted in the loss of carbon which could be attributed to the mineralization of organic matters. The increase in total nitrogen content in vermicompost was due to population of earthworm which contributes nitrogen to soil through vermicasts, decomposition of dead worms and release of mucus (Lee, 1985).

The available phosphorus content in E. foetida worked vermicompost was also significantly higher than EM-composted poultry litters (Table-3) and the magnitude of transformation of phosphorus from organic to inorganic state and into available form was found to be considerably higher in the case of earthworm inoculated organic wastes than in EM-composted poultry litters. The increase in phosphorous content in E. foetida was due to volume reduction of substrates due to vermicomposting process and increased microbial activity and by the acid phosphatase activity of cocoon and adult worms (Khan and Joergensen, 2009). The microbial biomass rapidly store significant amount of easily soluble phosphorus and also prevents it from absorption or other fixation processes (Satchell, 2009).

Similarly, the E. foetida worked vermicompost contained higher amount of Potassium than that obtained from EM-composted compost. Vermicasts have higher waste exchange capacity, total exchangeable potassium, manganese and calcium. This increase may be due to the breeding activity of earthworms that adds to the nutrient mineral content of the soil.

Conclusion

The study revealed that E. foetida has high efficacy than effective microorganism in composting the poultry litter waste and the biochemical analysis of the vermicomposts revealed the presence of various components in appropriate amount that reflect the quality of the organic manure. Hence, the earthworms species E. foetida can be employed for compostingpoultry litters obtained from poultry industries in order to get a value added product.

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