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Changes in chemical properties of different organic wastes under varying ratios for vermicomposting

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Abstract
Field studies were carried out at S K N College of agriculture, Jobner, Rajasthan. The aim of this work was to study the effect of different organic wastes, *viz*. agricultural waste, vegetable waste, seasonal weed and litter fall with cow dung in various ratios (8:4, 8:5 and 8:6) on chemical properties of vermicompost at 10, 20 and 30 days interval of vermicomposting. *Eisenia foetida* an epigeic earthworm was used in experiment. Result revealed that substrates and ratio of organic substrate to cow dung, significantly influenced the chemical properties of vermicompost. The feeding material having vegetable waste in ratio of 8:6 gave highest total nitrogen, total phosphorus and total potassium content and lowest C:N ratio and P^H. Whereas highest total organic carbon was obtained by vegetable waste in the ratio of 8:4.

Keywords: Organic waste, cow dung, vermicompost, *Eisenia foetida*

Introduction
Modern agriculture over the last some year have depended heavily on the inorganic chemical fertilizers. The latter are expensive and cause environmental problems. Several adverse effect of chemical fertilizers on soil, water, environment and the plant health have been reported (Singh 2003) [13]. Vermiculture is the science of breeding and raising earthworms. It defines the thrilling potential for waste management, compost production and can assure sustainable agriculture for the future. Earthworms play a key role in the soil biology and can eat all types of organic matter equal to their body weight each day and leaving worm castings as by product. These worm castings are called vermicompost. They serve as versatile natural bioreactors to harness energy and destroy soil pathogens. The worms do so by feeding voraciously on all biodegradable roughage such as leaves, kitchen waste and vegetable roughage etc. Vermiculture is being tested for treatment of agricultural, sugar and food processing wastes (Kale, 2000) [4]. The disposal of wastes has become important for a healthy quality of environment (Senapati and Julka, 1993) [11]. The results of several long-term studies have shown that the addition of compost improves soil health/physical properties of the soil by decreasing bulk density and increasing the water holding capacity of the soil (Weber *et al*., 2007) [14].

Materials and Methods
Earthworm and collection of organic waste
The *Eisenia foetida* an epigeic species of earthworm was used for vermicomposting which was collected from vermicompost unit of S K N College of agriculture, Jobner, Rajasthan. *Eisenia foetida* was chosen in this study because *Eisenia foetida* is a fast-growing earthworm that could convert organic waste rapidly. The organic wastes used in this study were Chopped Agricultural waste, vegetable waste, seasonal weed and litter fall. Mung straw, guar straw litter fall and weed were collected from Agronomy farm, cow dung was collected from dairy farm and vegetable wastes were collected from kitchen of hostels of Sri Karan Narendra College of Agriculture, Jobner.

Table 1: Initial chemical properties of substrate used in vermicomposting

Sr. No.	Substrate	OC (%)	C:N ratio	Macronutrient (%)		
				N	P	K
1	Agriculture waste	35.15	29.29	1.20	0.20	1.50
2	Vegetable waste	34.36	22.90	1.50	0.29	1.40
3	Seasonal weed	36.12	24.93	1.45	0.20	1.66
4	Litter fall	38.25	25.50	1.50	0.12	1.77
5	Cow dung	12.16	22.10	0.55	0.11	0.21

Experimental set up and preparation of vermibeds

The experiment was laid out in completely randomized design (CRD) with twelve treatments and three replications. Thirty six cemented bed of height 2.5 ft, 2.5 ft length and 2.5 ft breadth were used for decomposition of different substrate. Agricultural waste, vegetable waste, seasonal weed and litter fall were mixed with fresh cow dung in desirable ratios and kept for a period of 15 days for digestion of complex material present in substrates. After incubation of 15 days Weight quantity of (7-8 kg/bed) semi decomposed material were used to filling the bed. Semi decomposed material was incubated with earthworm (*Eisenia foetida*) and maintained the moisture level up to 70% and kept for 30 days for the process of vermicomposting.

Table 2: Ratio of different organic waste and cow dung

Treatments	Ratio	Symbols
Agricultural waste: Cow dung	8:4	T_1
Agricultural waste: Cow dung	8:5	T_2
Agricultural waste: Cow dung	8:6	T_3
Vegetable waste: Cow dung	8:4	T_4
Vegetable waste: Cow dung	8:5	T_5
Vegetable waste: Cow dung	8:6	T_6
Seasonal Weeds: Cow dung	8:4	T_7
Seasonal Weeds: Cow dung	8:5	T_8
Seasonal Weeds: Cow dung	8:6	T_9
Litter fall: Cow dung	8:4	T_{10}
Litter fall: Cow dung	8:5	T_{11}
Litter fall: Cow dung	8:6	T_{12}

Composting mixture were maintained at 70% moisture by watering as per need. Mixture were kept covered with moist gunny begs to avoid excess drying of upper layer and to have darkness for the activity of earthwarms. Loosing and turning were done at 10 days intervals. Vermicompost was harvested at the end of 30 days of incubation. The vermicomposting was completed in 45 days and the compost samples were collected at 10, 20, and 30 days intervals from each treatment for laboratory analysis.

Chemical analysis

pH of compost was determined by 1: 2.5 ratio of compost and water using digital pH meter (Jackson, 1973) [3]. Total organic carbon was determined by modified method of dry combustion method (Jackson, 1973) [3]. Total nitrogen was determined by Micro Kjeldahl's method as described by Piper, (1966) [7].

Total phosphorus was determined by vanado-molybdate phosphoric acid, yellow colour method using UV spectrophotometer (Jackson, 1967) [2]. Total potassium was determined by neutral normal ammonium acetate using flame photometer (Jackson, 1967) [2].

Result and discussion

P^{H}

The pH of the vermicomposting material was decreased with advancement of composting from alkaline to slightly neutral due to the accumulation of organic acids from microbial metabolism or from production of fulvic and humic acid during decomposition. The lowest pH was found under treatment T_6 (vegetable waste: cow dung) having ratio 8:6 that was 7.65, 7.41 and 7.22 for 10, 20 and 30 days, respectively and highest pH was observed under treatment T_{10} (litter fall: cow dung) having ratio 8:4 that was 8.91, 8.73 and 8.23 for 10, 20 and 30 days respectively. Similarly, Munnoli *et al*. (2010) [6] reported that in compost preparation earthworm reduced pH by *Eisenia foetida* as, 6.7 to 6.1; *Eudrilius eugeniae* 6.7 to 6.0 and *megasscolex megasscolex*, 6.7 to 6.4. Similar results were also found by Krishna murthi *et al.* (2010) [5] and reported that in both of the composting parthenium compost and chromalaema compost pH reduced8.77 to 7.74 at 30th to 90th days and in chromalaema compost it is 8.08 to 7.26 at 30th to 90th days of chromaleama compost and both of the compost recorded near neutral pH are due to the buffering of natural humus.

Total organic carbon

The organic carbon was decreased over period of vermicomposting from 10 to 30 days of process because on the account of organic carbon consumption by earthworm, the transformation in CO_2 by respiratory activity and formation of humic fraction.

Table 3: Periodical changes in pH, Organic carbon and C:N ratio during vermicomposting

Treatments	pH			Organic Carbon (%)			C:N Ratio		
	Period of sampling (Days)			Period of sampling (Days)			Period of sampling (Days)		
	10	20	30	10	20	30	10	20	30
T_1	8.01	7.69	7.41	34.19	31.11	28.45	20.08	14.10	12.04
T_2	7.99	7.66	7.39	33.81	28.88	28.05	19.98	13.81	11.94
T_3	7.91	7.59	7.33	33.78	27.97	27.95	19.92	13.78	11.86
T_4	7.73	7.46	7.30	36.79	32.69	29.28	19.61	13.63	11.72
T_5	7.71	7.45	7.28	36.24	31.74	28.61	19.67	13.47	11.59
T_6	7.65	7.41	7.22	35.91	31.69	28.11	19.20	13.39	11.60
T_7	8.11	7.89	7.52	33.87	28.81	24.58	20.67	14.42	12.31
T_8	8.09	7.82	7.49	33.69	28.55	24.11	20.58	14.22	12.26
T_9	8.02	7.78	7.41	33.61	28.49	23.88	20.44	14.17	12.12
T_{10}	8.91	8.73	8.23	32.81	27.67	23.50	20.91	14.92	12.82
T_{11}	8.81	8.69	8.19	32.69	27.42	23.24	20.90	14.72	12.63
T_{12}	8.73	8.40	8.05	32.65	24.39	23.11	20.86	14.65	12.44
S.Em+	0.29	0.32	0.32	0.29	0.32	0.32	0.39	0.39	0.29
CD (P=0.05)	0.86	0.94	0.94	0.86	0.94	0.94	1.15	1.15	0.86

treatments, while, it was remained at par with treatment (T_5) The organic carbon content was significantly superior in treatment (T_4) vegetable waste: cow dung (8:4) over all the other vegetable waste: cow dung (8:5) and the minimum content of organic carbon was observed in treatment (T_{12}) litter fall: cow dung (8:4) indicating lowest content of carbon in all combinations. Similar results were also found by Garg *et al*. (2011) reported that reduction of percent organic carbon from 11.88 percent to 9.45 percent was observed in periodical changes of composting. Similarly, Singh and Sharma (2002) reported that when wheat straw was treated with bioinoculants together, the total organic carbon content decreased from 30.10 to 26.48 per cent during composting and finally to 12.75 per cent during vermicomposting.

C:N Ratio

The C:N Ratio of vermicompost under various treatment of organic waste was observed in decreasing trend from 10 to 30 days. The lowest C:N Ratio was found under treatment vegetable waste: cow dung (8:6) that was 19.20, 13.39 and 11.60 per cent for 10, 20 and 30 days, respectively, where, as treatment vegetable waste: cow dung (8:5) remain at par with under treatment vegetable waste: cow dung (8:6) and highest C:N Ratio was found under treatment litter fall: cow dung (8:4) that was 20.91, 14.92 and 12.82 per cent for 10, 20 and 30 days, respectively.

Total nitrogen

The highest total nitrogen increased by 1.27 to 1.98 per cent recorded in vegetable waste: cow dung (8:6) where as treatment (T_6) vegetable waste: cow dung (8:5) remained statically at par with treatment (T_6) and the lowest total nitrogen content increased by 0.82 to 1.25 per cent recorded in litter fall: cow dung (8:4). It was probably due to increased activity of micro-organisms related to nutrient mineralization or ageing of casts enhanced the mineralization process. It was probably due to increased activity of micro-organisms related to nutrient mineralization or ageing of casts enhanced the mineralization process. Pattnaik and Reddy (2010) [8] observed that the highest total nitrogen was recorded in vegetable market waste. Similarly, Krishna Murthy *et al*, (2010) [5] observed that increasing trend in total nitrogen due to the increase in nitrogen value is result of carbon loss and probably because of mineralization of organic matter, so that the mineral N was retained in the nitrate form.

Total phosphorus

The phosphorus content of vermicompost under various treatment of organic waste was observed in increasing trend from 10 to 30 days. The highest total phosphorus content was found under treatment vegetable waste: cow dung (8:6) that was 0.91, 0.99 and 1.23 per cent for 10, 20 and 30 days, respectively, where, as treatment vegetable waste: cow dung (8:5) remain at par with under treatment vegetable waste: cow dung (8:6) and lowest phosphorus content was found under treatment litter fall: cow dung (8:4) that was 0.61, 0.71 and 0.84 per cent for 10, 20 and 30 days, respectively. The total phosphorus was increased due to increased activity of micro-organisms related to nutrient mineralization. Similarly, Nattudurai *et al*. (2014) concluded that N, P and K values were highly increased in vermicompost.

Table 4: Periodical changes in total nitrogen (per cent), phosphorus (per cent) and potassium (per cent) during vermincomposting

Treatments	Nitrogen (per cent)			Phosphorus (per cent)			Potassium (per cent)		
	Period of sampling (Days)			Period of sampling (Days)			Period of sampling (Days)		
	10	20	30	10	20	30	10	20	30
T_1	0.92	1.25	1.36	0.71	0.81	1.02	0.44	0.52	0.73
T_2	0.94	1.31	1.45	0.74	0.84	1.06	0.46	0.55	0.77
T_3	0.95	1.36	1.47	0.76	0.86	1.08	0.47	0.58	0.79
T_4	1.10	1.44	1.85	0.82	0.92	1.16	0.61	0.75	0.97
T_5	1.19	1.59	1.91	0.88	0.98	1.21	0.63	0.81	1.09
T_6	1.27	1.61	1.98	0.91	0.99	1.23	0.67	0.83	1.13
T_7	0.88	1.18	1.31	0.68	0.78	0.95	0.39	0.46	0.59
T_8	0.89	1.21	1.35	0.71	0.81	0.98	0.42	0.49	0.63
T_9	0.91	1.22	1.37	0.72	0.82	0.99	0.44	0.52	0.64
T_{10}	0.83	1.11	1.25	0.61	0.71	0.84	0.25	0.41	0.45
T_{11}	0.84	1.16	1.29	0.64	0.74	0.88	0.27	0.43	0.48
T_{12}	0.86	1.17	1.31	0.67	0.76	0.90	0.28	0.46	0.49
S.Em+	0.03	0.03	0.04	0.02	0.02	0.02	0.01	0.01	0.02
CD (P=0.05)	0.08	0.10	0.12	0.06	0.05	0.06	0.03	0.04	0.07

Total potassium

The highest total potassium content was found under treatment vegetable waste: cow dung (8:6) that was 0.67, 0.83 and 1.13 per cent for 10, 20 and 30 days respectively and lowest potassium content was found under treatment litter fall: cow dung (8:4) that was 0.25, 0.41 and 0.48 per cent for 10, 20 and 30 days respectively. The treatment vegetable waste: cow dung (8:5) remain at par with treatment vegetable waste: cow dung (8:6) for all days of vermicomposting. Similar results were also reported by Sannigrahi (2005) [10] reported that increase in earthworm population in compost bed decreased the period of vermicomposting and also increased the total nitrogen (from 1 to 1.14%), phosphorus (0.5 to 1%), potassium (1.8 to 2.4%), sodium (1.7 to 2.2%) and calcium (0.4 to 0.6%), respectively.

Conclusion

The use of earthworms for the conversion of different types of wastes into vermicomposting can truly bring in ‘economic prosperity’ for the farmers and the nations with ‘environmental security’ for the earth. The use of *E. foetida* (epigeic species) for vermicomposting of agricultural waste, vegetable waste, seasonal weed, litter fall and cow dung on the basis of nutrient content is an important indication that this technology will reduce the burden of synthetic fertilizers. Experimental data provide a sound basis that vermicomposting is a suitable technology for the conversion of agricultural waste, vegetable waste, seasonal weed, litter fall and cow dung into organic fertilizer. This study clearly demonstrates that the conversion of different types of wastes into vermicompost may not only reduce the burden of synthetic fertilizers but may also act as good soil conditioners and a source of plant nutrients in agriculture.

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