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Comparative Analysis and Enrichment of the Nutrient Composition of Agricultural Waste by Composting With Earthworm *Eudilus Eugineae and Eisenia Fetida*

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Abstract

India generates about 350 million tonnes of agricultural wastes every year. Vermicomposting is a good and affordable technique used to produce organic compost from organic waste with the aid of specific earthworm species. It is one of the economically and environmentally friendly methods of organic waste processing. It is a newly becoming organic solid waste management strategies. The present research work was carried with the objective exploring the vermicomposting processing. In this experiment, the agriculture waste such as coir wastes, leaf litter, Sugarcane trash and rice husk was processed by two earthworm species, *Eudilus eugineae* and *Eisenia fetida*. The macronutrients such as carbon, nitrogen, phosphorus, potassium and calcium were evaluated in vermicompost and conventional compost and assessed the growth efficiency of plant, *Abelmoschus esculentus*. The nutrient status and growth efficiency of vermicompost processed by earthworm species produced from agriculture waste were more than conventional compost. Moreover, the vermicompost produced by *Eudilus eugineae* processed higher nutrients and growth efficiency than that of *Eisenia fetida*. This study promising that vermicomposting is an ecofriendly method to solve the acute problem of solid waste.

Key words: Agricultural wastes, Eudilus eugineae , Eisenia fetida and Abelmoschus esculentus.

Introduction

The degradation of organic matter by earthworm is a process that can be used to deal with the huge amount of organic matter waste derived from urban environments. The burial of organic wastes in landfills also presents problems. In addition, there may be societal issues related to acceptance of landfill as a disposal route. Most importantly, waste disposal methods may fail to recover the energy present in organic waste at a time when fossil energy is becoming increasingly expensive (Riley et al., 2008). Organic wastes can be processed locally by vermicomposting, which decreases the cost of transport to water treatment plants, landfills or incinerations. Short term experiments have shown the earthworms have a stimulating effect on nutrient turnover. However, long-term experiment to evaluate the need for regular addition of organic matter to maintain earthworm population would be valuable (Pelosi et al., 2009).

Earthworms are the supreme component of soil macrofauna and are the most important soil invertebrates responsible for developing and maintain the nutritive value of soil by converting biodegradable material and organic waste into nutrient rich vermicast (Kaushal et al., 1985). Earthworms are acknowledging as “Ecosystem Engineers” as they extensively influence physical, chemical and biological properties of soil (Pelosi et al., 2014). Earthworms boost soil physical properties such as hydrolic conductivity, porosity, bulk density infiltrability aggregate stability etc. (Devkota et al., 2014). Earthworms improve nutrient availability by ingesting organic residues of different C:N ratio (Patnaik and Dash, 1990). These epigeic earthworm species successfully utilized for degradation of all types of agricultural wastes (Amoji et al., 1998; Karthikeyan, 2000; Tripathy and Bhardwaj 2003; Chaudhuri, 2005 and Garg et al., 2005). Hence, in this study an attempt is made to explore the efficiency of earthworm in converting the Agriculture waste into useful fertilizers and to assess the effects of different types of vermicomposts on the growth of the plant, *Abelmoschus esculentus.*

2. Materials And Methods

2.1 Collection of raw materials for composting:

The coir wastes were collected from Manakudi Coir industries, near Kanyakumari. The other raw materials such as sugarcane trash, rice husk and leaf litter were collected from the Alanganallur sugar factory, the local rice mill near Thiruppalai and Yadava College campus, respectively. The coir wastes and the sugarcane trash were shredded to a length of 2-3 cm pieces. All these compostable organic materials were dried for a week and then subjected to pre decomposition.

2.2 Pre digestion of compost materials:

The selected organic wastes were mixed with equal amount of fresh cow dung in plastic troughs (60 x 45 x 30 cm) separately and allowed for pre digestion by sprinkling water regularly. After 45 days the pre-digested substrates were treated with earthworms.

2.3 Collection and maintenance of experimental animals:

The two efficient epigeic species of adult earthworms, *Eudrilus eugeniae* and *Eisenia fetida* were procured from the SACS Vermiery, Hawa Valley near Madurai. The worms were acclimatized to the laboratory conditions for a period of 15 days before the commencement of the experiment.

2.4 Preparation of vermibed:

About 3 kg from the pre-digested materials of leaf litter, coir wastes, sugarcane trash and rice husk and were taken in four sets of rectangular culture troughs of equal size (60 x 45 x 30 cm). Among the 5 troughs, the first one is without earthworm (Control or Conventional Compost trough) whereas the second and third with *E. fetida* and the fourth and fifth with *E. eugeniae*.

2.5 Inoculation of earthworms:

Thirty adult earthworms of same length and weight of *E. fetida and E. eugeniae* were introduced separately into their respective experimental troughs of each waste. Water was sprinkled with regular intervals in all the troughs to maintain the moisture content of 75-85% RH and a temperature at 25 ºC. The culture troughs were covered with wet muslin net to prevent the invasion of foreign materials and outgoing of worms. The setup was maintained in a shadow place to avoid direct sunlight. The vermicomposting process was extended for a period of 45 days. Before introducing the earthworms into the troughs i.e., at the initial day (0 day) and after an interval of 15, 30 and 45th day, the samples of both compost (without earthworm) and vermicompost were collected and analyzed for the biochemical Organic carbon, Nitrogen, Phosphorous, Potassium and Calcium.

2.6 Biochemical Estimation

To quantify the organic Carbon in the compost, Walkley and Black's rapid titration method was followed Jackson 1973. Total nitrogen was determined using MicroKjeldhal method Umbreit et al., 1974. Phosphorus was estimated by Vogel's technique 1963. Available potassium and calcium were detected using Flame photometer (Elico; Model CL 378).

2.7 Designing of pot experiment:

To assess the fertility of different compost processed by earthworms, the plant Abelmoschus esculentus was selected. About 2 kg of ordinary fertile garden soil, conventional compost (without earthworm) and vermicomposts of different wastes were taken in separate pots and in each pot 10 seeds of A. esculents were sowed and maintained for a period of 50 days. The data related to morphometry and bionomics of the plant i.e., height of the plant, length and number of leaves and length and weight of the fruits were observed and recorded.

2.8 Statistical Analysis: Wherever required, the data were subjected to statistical analysis, like Standard Deviation (S.D), Pearsons product moment Correlation co-efficient (r) and one way ANOVA test.

3. RESULTS

The chemical composition of the compost and vermicomposts produced from the leaf litter, coir waste, sugarcane trash and rice husk by the activity of the earthworms, *E. fetida and E. eugeniae* are presented in Table 1-6.

3.1 Organic Carbon:

The decrease of organic carbon was higher in all the vermicomposts worked with earthworms than the conventional composts i.e without earthworms. The percentage of carbon in compost prepared from leaf litter was reduced from 38.65 to 28.89 and 28.0 % at the end of 45th day by *E.fetida and E. eugeniae*, respectively. Though the unprocessed coir wastes contain high amount of carbon (56.15%), it was found to be decreased progressively by the action of earthworms, *E. fetida* (42.79%) and *E. eugeniae* (41.43%). The reduction of organic carbon was greater by *E.eugeniae* in both sugarcane trash (from 44.54 to 29.05%) and rice husk (42.01 to 33.39%) than *E. fetida* (from 44.54 to 32.06; 42.01 to 37.33%) .

3.2 Nitrogen:

The highest nitrogen content was observed in coir waste (0.91%) than leaf litter (0.85%), sugarcane trash (0.74%) and rice husk (0.67%) at initial stage of composting. But at the end of 45th day, the compost prepared from the leaf litter showed very higher percentage of nitrogen (1.30) by *E. eugeniae than E. fetida* (1.18). Minimum quantity of nitrogen was noticed in the rice husk (0.87%) composted by *E. fetida*. The level of nitrogen was found to be 1.14 and 1.20%; 1.12 and 1.18% in the final day vermicompost prepared from sugarcane trash and rice husk by *E. fetida and E. eugeniae* respectively.

3.3 C/N ratio:

The C/N ratio was maximum (62.7) in rice husk and it was found to be less in coir wastes (61.7), sugarcane trash (60.19) and leaf litter (45.47) at the initial stage. From the data it is clear that the C/N ratio of leaf litter worked with both *E. fetida and E. eugeniae* had been reduced significantly to lower level (24.48 and 22.4) than the conventional compost (without earthworms) (30.18). Of the two species selected for the present investigation, *E. eugeniae* was potential in reducing the C/N ratio compared to *E. fetida* in all the tested wastes.

3.4. Phosphorus:

The level of phosphorus at the commencement of composting 0.16, 0.14, 0.12 and 0.07% in leaf litter, coir waste, sugarcane and rice husk respectively. After 45 days the above substrates worked with earthworm, *E. fetida* contained was less phosphorus (0.33, 0.30, 0.26 and 0.23%) than the compost obtained from the activity of *E. eugeniae* (0.38, 0.36, 0.28 and 0.25%). The compost without earthworms showed a minimum increase in the level phosphorus.

3.5 Potassium

The potassium content of the vermicompost was increased in the order of rice husk (0.15%), sugarcane trash (0.16%), coir waste (0.19%) and leaf litter (0.28%) at the beginning of composting. The leaf litter composted by *E. eugeniae* contained more potassium (0.57%) than coir waste (0.43%), sugarcane trash (0.41%) and rice husk (0.39%). Similarly, the level of potassium was found to be decreased in the order of leaf litter (0.41%), coir wastes (0.29%), sugarcane (0.29%) and rice husk (0.25%) in their respective composts without earthworms.

3.6 Calcium:

The initial level of calcium was reported to be 0.22, 0.20, 0.19, and 0.11% in leaf litter, coir waste, sugarcane and rice husk respectively. After 45 days, the calcium level was remarkably increased by the *E. eugeniae* from 0.22 to 0.70%in leaf litter. The amount of calcium was found to be very less (from 0.11 to 0.53%) in rice husk processed by *E. fetida*. However, the coir wastes (0.67%) and sugarcane (0.64%) vermicomposts worked with *E. eugeniae* showed moderate increase in the level of calcium at the end composting.

3.7 Pot experiment:

The results revealed that the plants grown on leaf litter compost processed by *E. eugeniae* attained maximum height (61.4cm) compared to other wastes (coir wastes: 51.3; sugarcane trash: 47.1; and rice husk: 43.7cm), conventional composts (leaf litter: 38.4; coir wastes: 36.4; sugarcane trash: 31.9; and rice husk: 30.8cm) and garden soil (28.9cm). Similarly, other parameters including number and length of leaves, length and weight of the fruits were greater in leaf litter than the coir wastes, sugarcane trash and rice husk vermicomposts *E. eugeniae*. The plants grown on rice husk composted with *E. fetida* showed lesser height (33.0cm), length (10.3cm) and number of leaves (10.2/plant), fruit length (11.9cm) and weight (12.9gm) than the other wastes worked with the same earthworm species.

4. Discussion

The results of the present investigation revealed that the vermicomposts prepared from different organic wastes processed by earthworms, *E. fetida and E. eugeniae* were used as best organic fertilizers in terms of nutritional quality and their impact on the growth of the vegetable plant, Abelmoschus esculentus. It is well established that the ability of earthworms to consume a wide range of organic wastes such as leaf litter, vegetable and agricultural wastes and the worm casting are rich in nitrogen, calcium, magnesium, potassium and phosphorus as well as many beneficial enzymes and bacteria (Mariappan et al., 2003). Vermicastings are the rich sources of macro and micronutrients, vitamins, enzymes, antibiotics, growth hormones and immobilized micro flora.(Nijhawan and kanwar, 1952; Gaur, 1982 and Bhawalkar, 1991).

In the present investigation, the organic carbon content was significantly reduced with the advancement of duration of composting. A gradual decline in the content of organic carbon was noticed in the coconut waste recycling by earthworms Earthworms increased the level of nitrogen invariably in all the selected organic wastes during the process of composting. The increase in the amount of nitrogen in compost by earthworm may be due to the nephridial excretion and mucus secretion mineralized from organic matter in soil.

The carbon – to – nitrogen (C/N) ratio is an important factor affecting fertility of soil which is considerably altered by earthworms. Reduction in C/N ratio speed up the decomposition process of the organic matter and make it available to plants. Microorganism in the compost digest C as an energy source and ingest N as a protein source. t the phosphorus content was higher in worm worked compost than the conventional composts.The observations made by Graff (1971); Watanable (1975); and Ramalingam (1997); strongly support the enhancement of potassium in the vermicomposts processed by *E. fetida and E. eugeniae*. The micronutrient calcium was also increased in all selected organic wastes worked with earthworms.

The results of the pot experiments carried out with the garden soil, conventional composts and the composts prepared from the action of earthworms, *E. fetida and E. eugeniae* have highly altered the growth parameters of the plant *Abelmoschus esculentus*. Among the vermicomposts tested in the present investigation for plant growth, leaf litter vermicompost showed higher values related to the number and length of leaves, length and weight of the fruits of *Abelmoschus esculentus* than the coir wastes, sugarcane trash and rice husk. The present study indicates that among the two species of earthworms chosen for the investigation, *E. eugeniae* is highly efficient in composting the wastes into useful organic manure than *E. fetida*. Hence, from the present study, it is suggested that the leaf litter vermicompost prepared by using *E. eugeniae* is highly suitable for agricultural fields to improve the yield and production by its nutrient quality as recommended by Narayana (2001).

Table 1: Nutrient composition (%) of Vermicompost of leaf litter processed by *E. fetida*. Each value represents the mean of (X ± S.D) 3 estimates.

Parameters	Initial (0 day)	15th day		30th day		45th day	
		Compost	Vermi compost	Compost	Vermi compost	Compost	Vermi compost
Organic Carbon	38.65 ± 0.65	36.13 ± 0.15	34.79 ± 0.80	33.43 ± 1.03	30.18 ± 1.03	30.48 ± 0.52	28.89 ± 0.81
Nitrogen	0.85 ± 0.03	0.91 ± 0.02	0.93 ± 0.04	0.95 ± 0.02	0.98 ± 0.03	1.01 ± 0.01	1.18 ± 0.04
Phosphorus	0.16 ± 0.01	0.21 ± 0.016	0.23 ± 0.009	0.26 ± 0.046	0.27 ± 0.009	0.30 ± 0.018	0.33 ± 0.024
Potassium	0.28 ± 0.03	0.32 ± 0.04	0.37 ± 0.02	0.35 ± 0.05	0.43 ± 0.02	0.41 ± 0.02	0.53 ± 0.03
Calcium	0.22 ± 0.02	0.28 ± 0.03	0.32 ± 0.04	0.37 ± 0.02	0.42 ± 0.04	0.57 ± 0.02	0.62 ± 0.01
C / N Ratio	45.47 ± 1.01	39.70 ± 1.01	37.41 ± 0.25	35.19 ± 0.31	32.94 ± 2.01	30.18 ± 0.91	24.48 ± 0.86

Table 2: Nutrient composition (%) of Vermicompost of leaf litter processed by *E. eugeniae.* Each value represents the mean of (X ± S.D) 3 estimates.

Parameters	Initial (0 day)	15th day		30th day		45th day	
		Compost	Vermi compost	Compost	Vermi compost	Compost	Vermi compost
Organic Carbon	38.65 ± 0.65	36.13 ± 0.15	33.62 ± 0.33	33.43 ± 1.03	30.78 ± 0.55	30.48 ± 0.52	28.00 ± 0.06
Nitrogen	0.85 ± 0.03	0.91 ± 0.02	0.95 ± 0.02	0.95 ± 0.02	0.99 ± 0.02	1.01 ± 0.01	1.30 ± 0.01
Phosphorus	0.16 ± 0.01	0.21 ± 0.016	0.25 ± 0.018	0.26 ± 0.046	0.28 ± 0.024	0.30 ± 0.018	0.38 ± 0.024
Potassium	0.28 ± 0.03	0.32 ± 0.04	0.39 ± 0.04	0.35 ± 0.05	0.45 ± 0.05	0.41 ± 0.02	0.57 ± 0.01
Calcium	0.22	0.28	0.35	0.37	0.50	0.57	0.70

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	± 0.02	± 0.03	± 0.02	± 0.02	± 0.01	± 0.02	± 0.02
C / N Ratio	45.47 ± 1.01	39.70 ± 1.01	35.39 ± 0.04	35.19 ± 0.31	31.09 ± 1.02	30.18 ± 0.91	22.40 ± 1.07

Table 3: Nutrient composition (%) of Vermicompost of coir wastes processed by *E fetida*. Each value represents the mean of (X ± S.D) 3 estimates.

Parameters	Initial (0 day)	15th day		30th day		45th day	
		Compost	Vermi compost	Compost	Vermi compost	Compost	Vermi compost
Organic Carbon	56.15 ± 0.26	54.63 ± 0.31	51.80 ± 0.53	50.74 ± 0.59	47.33 ± 0.27	45.56 ± 0.27	42.79 ± 0.31
Nitrogen	0.91 ± 0.01	0.94 ± 0.01	0.97 ± 0.03	0.98 ± 0.04	1.12 ± 0.01	1.09 ± 0.02	1.14 ± 0.02
Phosphorus	0.14 ± 0.01	0.19 ± 0.024	0.22 ± 0.009	0.25 ± 0.015	0.27 ± 0.009	0.28 ± 0.009	0.30 ± 0.018
Potassium	0.19 ± 0.01	0.21 ± 0.02	0.25 ± 0.05	0.25 ± 0.01	0.32 ± 0.04	0.29 ± 0.02	0.39 ± 0.04
Calcium	0.20 ± 0.02	0.24 ± 0.01	0.30 ± 0.03	0.35 ± 0.03	0.41 ± 0.01	0.54 ± 0.04	0.59 ± 0.02
C / N Ratio	61.70 ± 1.01	58.12 ± 1.02	53.40 ± 1.04	51.78 ± 1.03	42.26 ± 1.01	41.80 ± 2.04	37.54 ± 1.05

Table 4: Nutrient composition (%) of Vermicompost of coir wastes processed by *E. eugeniae*. Each value represents the mean of (X ± S.D) 3 estimates.

Parameters	Initial (0 day)	15th day		30th day		45th day	
		Compost	Vermi compost	Compost	Vermi compost	Compost	Vermi compost
Organic Carbon	56.15 ± 0.26	54.63 ± 0.31	52.09 ± 0.31	50.74 ± 0.59	46.58 ± 0.41	45.56 ± 0.27	41.43 ± 0.41
Nitrogen	0.91 ± 0.01	0.94 ± 0.01	0.99 ± 0.01	0.98 ± 0.04	1.15 ± 0.03	1.09 ± 0.02	1.20 ± 0.01
Phosphorus	0.14 ± 0.01	0.19 ± 0.024	0.24 ± 0.016	0.25 ± 0.015	0.28 ± 0.033	0.28 ± 0.009	0.36 ± 0.040
Potassium	0.19 ± 0.01	0.21 ± 0.02	0.27 ± 0.02	0.25 ± 0.01	0.35 ± 0.01	0.29 ± 0.02	0.43 ± 0.02
Calcium	0.20 ± 0.02	0.24 ± 0.01	0.33 ± 0.03	0.35 ± 0.03	0.48 ± 0.01	0.54 ± 0.04	0.67 ± 0.02
C / N Ratio	61.70 ± 1.01	58.12 ± 1.02	52.62 ± 1.04	51.78 ± 1.03	40.50 ± 2.02	41.80 ± 2.04	34.53 ± 1.02

Table 5: Nutrient composition (%) of Vermicompost of sugarcane trash processed by *E. fetida*. Each value represents the mean of (X ± S.D) 3 estimates.

Parameters	Initial (0 day)	15th day		30th day		45th day	
		Compost	Vermi compost	Compost	Vermi compost	Compost	Vermi compost

Organic Carbon	44.54 ± 1.01	43.58 ± 0.87	42.73 ± 1.23	41.39 ± 1.09	38.99 ± 1.01	39.13 ± 2.03	35.91 ± 0.98
Nitrogen	0.74 ± 0.04	0.78 ± 0.02	0.81 ± 0.02	0.82 ± 0.01	0.93 ± 0.02	0.91 ± 0.01	1.12 ± 0.02
Phosphorus	0.12 ± 0.02	0.16 ± 0.009	0.20 ± 0.018	0.20 ± 0.009	0.23 ± 0.033	0.24 ± 0.016	0.26 ± 0.024
Potassium	0.16 ± 0.03	0.18 ± 0.02	0.22 ± 0.01	0.21 ± 0.02	0.28 ± 0.04	0.29 ± 0.02	0.37 ± 0.01
Calcium	0.19 ± 0.01	0.22 ± 0.02	0.28 ± 0.04	0.33 ± 0.02	0.38 ± 0.03	0.51 ± 0.01	0.55 ± 0.03
C / N Ratio	60.19 ± 0.98	55.87 ± 2.01	52.75 ± 1.03	50.48 ± 3.01	41.92 ± 0.99	43.00 ± 2.02	32.06 ± 1.01

Table 6: Nutrient composition (%) of Vermicompost of sugarcane trash processed by *E. eugeniae*. Each value represents the mean of (X ± S.D) 3 estimates.

Parameters	**Initial (0 day)**	**15th day**		**30th day**		**45th day**	
		Compost	Vermi compost	Compost	Vermi compost	Compost	Vermi compost
Organic Carbon	44.54 ± 1.01	43.58 ± 0.87	41.56 ± 1.02	41.39 ± 1.09	37.02 ± 3.02	39.13 ± 2.03	34.28 ± 2.99
Nitrogen	0.74 ± 0.04	0.78 ± 0.02	0.81 ± 0.03	0.82 ± 0.01	0.90 ± 0.03	0.91 ± 0.01	1.18 ± 0.03
Phosphorus	0.12 ± 0.02	0.16 ± 0.009	0.21 ± 0.016	0.20 ± 0.009	0.26 ± 0.024	0.24 ± 0.016	0.28 ± 0.009
Potassium	0.16 ± 0.03	0.18 ± 0.02	0.25 ± 0.03	0.21 ± 0.02	0.33 ± 0.02	0.29 ± 0.02	0.41 ± 0.01
Calcium	0.19 ± 0.01	0.22 ± 0.02	0.31 ± 0.02	0.33 ± 0.02	0.45 ± 0.05	0.51 ± 0.01	0.64 ± 0.03
C / N Ratio	60.19 ± 0.98	55.87 ± 2.01	51.31 ± 1.02	50.48 ± 3.01	41.13 ± 0.8	43.00 ± 2.02	29.05 ± 3.02

Table 7: Nutrient composition (%) of Vermicompost of rice husk processed by *E. fetida*. Each value represents the mean of (X ± S.D) 3 estimates.

Parameters	Initial (0 day)	15th day		30th day		45th day	
		Compost	Vermi compost	Compost	Vermi compost	Compost	Vermi compost
Organic Carbon	42.01 ± 0.02	40.75 ± 1.05	38.72 ± 1.98	38.21 ± 1.02	35.65 ± 2.05	35.76 ± 3.05	32.48 ± 1.03
Nitrogen	0.67 ± 0.01	0.72 ± 0.02	0.75 ± 0.01	0.74 ± 0.03	0.81 ± 0.03	0.77 ± 0.04	0.87 ± 0.02
Phosphorus	0.07 ± 0.02	0.11 ± 0.028	0.14 ± 0.016	0.19 ± 0.016	0.21 ± 0.016	0.21 ± 0.024	0.23 ± 0.009
Potassium	0.15 ± 0.02	0.17 ± 0.02	0.21 ± 0.02	0.20 ± 0.05	0.26 ± 0.02	0.25 ± 0.03	0.32 ± 0.02
Calcium	0.11 ± 0.01	0.17 ± 0.02	0.20 ± 0.03	0.29 ± 0.04	0.35 ± 0.03	0.48 ± 0.04	0.53 ± 0.03
C / N Ratio	62.70 ± 2.02	56.60 ± 4.04	51.63 ± 2.03	51.64 ± 1.03	44.01 ± 1.06	46.44 ± 2.05	37.33 ± 2.05

Table 8: Nutrient composition (%) of Vermicompost of rice husk processed by *E. eugeniae*. Each value represents the mean of (X ± S.D) 3 estimates.

Parameters	Initial (0 day)	15th day		30th day		45th day	
		Compost	Vermi compost	Compost	Vermi compost	Compost	Vermi compost

Organic Carbon	42.01 ± 0.02	40.75 ± 1.05	37.21 ± 2.01	38.21 ± 1.02	34.65 ± 0.85	35.76 ± 3.05	31.48 ± 1.03
Nitrogen	0.67 ± 0.01	0.72 ± 0.02	0.76 ± 0.01	0.74 ± 0.03	0.82 ± 0.02	0.77 ± 0.04	0.94 ± 0.02
Phosphorus	0.07 ± 0.02	0.11 ± 0.028	0.18 ± 0.018	0.19 ± 0.016	0.22 ± 0.009	0.21 ± 0.024	0.25 ± 0.009
Potassium	0.15 ± 0.02	0.17 ± 0.02	0.24 ± 0.04	0.20 ± 0.05	0.31 ± 0.01	0.25 ± 0.03	0.39 ± 0.03
Calcium	0.11 ± 0.01	0.17 ± 0.02	0.27 ± 0.02	0.29 ± 0.04	0.42 ± 0.02	0.48 ± 0.04	0.62 ± 0.01
C / N Ratio	62.70 ± 2.02	56.60 ± 4.04	48.96 ± 3.01	51.64 ± 1.03	42.26 ± 0.02	46.44 ± 2.05	33.39 ± 2.03

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