VERMICOMPOSTING OF BROILER FARM WASTE

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Abstract

The objective of the study was to know the difference in growth of two species earthworms as vermicomposting agents of broiler farm waste. The study also proposed to know the potency of the worms as broiler feed in term of nitrogen retention and metabolizable energy, moreover to know the quality of the produced composts. This experimental study was done triplicate in the period of eight weeks. There were two species of earthworm used, namely: Lumbricus rubellus and Eisenia fetida. The weights of the earthworms were measured every week, while the nutritional values of the worms were measured after the 8th measurement of worm's weight. At the end of vermicomposting, carbon, nitrogen, phosphorus and potassium contents of the compost were analyzed. The obtained data analyzed using t-test. The results showed that both earthworms can be used as vermicomposting agent of broiler farm waste. The nitrogen retention and metabolizable energy of the worms are also representing similar values, so that the worms could interchangeable to be use as broiler feed. Finally, the result of study indicates that earthworm species provide no significant effect on the C/N ratio, nitrogen, phosphorus, and potassium contents of the resulted vermicomposts. Since those organic matter contents above the minimum requirement for organic compost of National Standardization of Indonesia, the vermicomposts were suitable to be used as single source of fertilizer.

Key words: vermicomposting, broiler farm waste, compost, earthworm

INTRODUCTION

One of the most abundance farms in Indonesia is broiler farm. In spite of produces high values of food, broiler farm is also produces waste that may cause environmental pollution. Broiler farm waste consists of liquid waste and solid waste. Different with liquid waste, which is easy to be handling, the solid waste is require more effort because of its volume and load. The solid waste mainly consists of broiler feces and urine. Depends on the method of rearing, sometime litter of rice hull may increase waste volume. Broiler feces have high nitrogen content that makes its C/N ratio low. Therefore, it is not suitable for direct use as compost feedstock. In order to make the waste more applicable, it should be mixed with other organic matter that has high C/N ratio. Organic matter that easily found in neighborhood and has high C/N ratio is *Albizzia falcata* sawdust. Besides conventional composting, there is another composting method that gives more benefits, viz., vermicomposting. This composting method provides at least two benefits, namely earthworm biomass as source of protein and organic fertilizer that being considered as green fertilizer [6]. There are two species of earthworm can be used in vermicomposting, namely *Lumbricus rubellus* (true red worm or dung worm) and *Eiseina fetida* (red worm) previously known as *Eisenia foetida* [3] Although, they are of the same family *Lumbricidae*, both of them have different characteristics including in accelerating composting process which depends on organic content of composting feedstock. Unfortunately, the data of broiler farm waste composting were available yet. Therefore, the objective of this study was to know the difference in growth between two species of earthworms as vermicomposting agents of broiler farm waste. It is also proposed to know the potency of the worms as broiler feed in term of nitrogen retention and metabolizable energy, and to know the quality of the produced composts.

MATERIAL AND METHOD

The experiments was undertaken at the Microbiology and Waste Management Laboratory. Faculty of Animal Husbandry. Universitas Padjadjaran Indonesia. This study used broiler farm waste from Broiler Backyard Farming at Rancaekek District, Sumedang Regency. Chemical analyisis indicated that the broiler waste has C/N ratio of 11. In order to increase the C/N ratio into 30, sawdust of *A. Falcata* which C/N ratio of 200 was added into the the broiler feces. The obtained feedstock then composted for 15 days. Composting method used in this study was Berkeley method that had been developed at California University, USA [4]. The feedstock was turned every 3 days to maintain oxygen content and sprayed with small amount of water to maintain the relative humidity of the substrate of 40-60%. In the last day, two samples of compost were taken and then analyzed in the laboratory for its contents of carbon, nitrogen, phosphorus and potassium. Then compost used for vermicomposting feedstock. The feedstock was devided into four containers sized of 27.5 cm x 21.5 cm x 12.5 cm. Two containers were treated with *L. rubellus*, and the other two with *E.fetida*. Seedling density was 2kg/m^2 (66 erathworms). Earthworms were obtained from the Microbiology and Waste Management Laboratory. The vermicomposting carried out for two months. At the end of experiment, all earthworma were collected and weighted, then two samples of vermicompost from all containers were taken for carbon, nitrogen, phosphorus, and potassium analysis in the laboratory. The obtained earthworms used as source of protein in broiler ration replacing protein of fish meal. The rations of broiler (R_{Lr} and R_{Ef}) contain 12% earthworm meal (Table 1). The result of chemical analysis showed that both rations was in the range of broiler nutrient and metabolizable energy requirement (Table 2). The t-test was applied to differenciate the increase of both earthworms biomass, as well as carbon, nitrogen, phosphorus, and potassium contents of the resulted compost.

Tabel 1. Ration ingridient

Constituent	Ration	
	R_{Lr}	R_{Es}
Earthworm meal	12,00	12,00
Soybean cake	19,00	19,00
Coconut cake	5,00	5,00
Corn meal	58,00	58,00
Rice brand	2,50	2,50
Coconut oil	1,50	1,50
CaCO3	0,50	0,50
DCP	1,00	1,00
Premix	0,50	0,50
Total	100,00	100,00

Legend: R_{Lr} = *L.rubellus* containing ration
REs = *E.fetida* containing ration

Table 2. Nutrient content and metabolizable energy of the ration.

Nutrient	R_{Lr}	R_{Ef}	Requirement[5]
Crude protein (%)	21,99	22,25	22,00
Crude fat (%)	5,79	5,82	5,00-6,00
Crude fiber (%)	3,398	3,374	≤ 8,00
Calsium (%)	0,633	0,635	1,10—1,20
Phosphorus (%)	0,368	0,370	0,60-0,90
Lysine (%)	0,503	0,509	0,90-1,10
Methionine (%)	0,2578	0,260	0,40
Met. + cystine (%)	0,2555	0,255	0,70-0,86
ME (Kcal/kg)	3040,35	3034,95	3000

RESULTS AND DISCUSSIONS

The average increase of *L. rubellus* and *E. fetida* biomass resulted from vermicomposting of broiler farm waste were presented on Table 3. This result of study showed that the increase of *L. rubellus* biomass in average of 4.03 gram/worm were almost the same than that of *E. fetida* (4.02 gram/worm). The result of T-test approved that both biomasses were not significantly different ($t_{stat} < t_{.05}$) due to the quality of composting feedstock. Although, the two earthworm species have different growth pattern, they have similarity in using their feed. They used material of feedstock with similar quality of organic matter. The initial

C/N ratio of the feedstock was 30, while after being composted the C/N ratio was 17.3. Moreover, at the end of vermicomposting the C/N ratio of feedstock with *L.rubellus* was decreased to 13.16, while the one with *E.fetida* was decreased to 13.14. Those C/N ratios showed that both earthworms use almost the same amount of carbon and nitrogen. Actually, this vermicomposting can be prolonged since the earthworm may survive in feedstock with C/N ratio of 11 [1] even 10 [8].

The nitrogen retention provided by *L.rubellus* meal were varied between 48.78 – 52.21%, while *E.fetida* provide 48.98-51.91%. The result of t–test showed that *L.rubellus* meal provide nitrogen retentions that is not significantly differing ($s_{stat.}<t_{.05}$) to that of *E.fetida*. Furthermore, both earthworms also provide varying metabolizable energy. *L.rubellus* resulted in metabolizable energy of 3050.38 – 3892.85 Kcal/kg, while *E.fetida* was 3098.21 – 3536.12 Kcal/kg. According to the result of t-test, the effect *L.rubellus* on metabolizable energy were not significantly differing ($t_{stat.}<t_{.05}$) to that of *E. fetida*. From the result of nutrient analysis, it was known that *L.rubellus* contains crude protein 61.24%, crude fat 8.98%, crude fiber 0.4%, calsium 0.9%, phosphorus 1.00%, lysine 2.8%, methionine 0.06% and metabolizable energy 3443 Kcal/Kg. Meanwhile, *E.fetida* meal contain crude protein 63.43%, crude fat 9.28%, crude fiber 0.2%, calsium 0.92%, phosphorus 1.92%, lysine 2.85%, methionine 0.08%, and metabolizable energy 3400 Kcal/kg. If compared with fish meal, protein content, nitrogen retention and metabolizable energy of *L. rubellus* and *E.fetida* were equal to protein content of fish meal, viz 61%, 50% and 3300 Kcal/kg [2] [9] [10].

Table 3. The average of biomass increase of *L. rubellus and E.fetida*

Replication	Biomass increase of *L.rubellus* (gram/worm)	Biomass increase of *E.fetida* (gram/worm)
1	4.13	4.02
2	3.99	4.12
3	3.99	4.08
4	4.11	3.95
5	3.95	4.12
6	4.15	4.00
7	3.97	3.98
8	3.99	3.91
9	4.01	3.89
10	4.04	4.11

Table 4. Nitrogen retention and metabolizable energy of *L rubellus* meal and *E.fetida* meal.

Replication	Nitrogen retention (%)		Metabolizable energy (Kcal/kg)	
	L.ubellus meal	*E.fetida* meal	*L.rubellus* meal	*E.fetida* meal
1	50.42	49.79	3354.99	3329.02
2	52.21	51.91	3208.61	3536.12
3	51.33	48.98	3452.90	3345.89
4	49.99	49.89	3321.45	3211.53
5	48.99	47.77	3050.38	3486.23
6	51.00	47.25	3892.85	3412.09
7	51.18	51.70	3258.15	3309.21
8	50.45	49.19	3324.89	3098.48
9	48.78	51.15	3286.78	3211.11
10	49.85	50.26	3298.91	3350.55

The qualities of resulted vermicomposts were presented on Table 5. Carbon content of *L.rubellus* vermicomposts were ranging from 21.54 – 26.55%, and *E.fetida* vermicomposts were 22.91 – 24.73%. Those carbon contents make the ultimate C/N ratio of the vermicomposts become 13.16 and 13.14 respectively. The nitrogen contents of *L.rubellus* vermicomposts were between 1.75 – 2.09%, and *E.fetida's* varies between 1.62 – 2.01%. On the same table, it can be seen that phosphorus content of *L.rubellus*

vermicomposts were 0.12 – 0.25%, while the phosphorus content of *E.fetida* vermicomposts were 0.12 – 0.30%. Finally, the potassium content of *L.rubellus* vermicomposts were 0.08 – 0.13%, and *E.fetida* were 0.09 – 0.12. However, based on the result of t-test, those nitrogen, phosphorus and potassium contents of vermicomposts were not significantly differing ($t_{stat} < t.05$) to each other. It is due to the similar quality of feedstocks. Since a good organic compost should has C/N ratio of 10 - 20, and at least has nitrogen, phosphorus, and potassium content of 0.4%, 0.1%, and 0.2% respectively [7]; therefore both produced vermicomposts were can be used as organic fertilizer.

Table 5. Nitrogen. Phosphorus and Potassium contents of resulted vermicompost

Replications	*L.rubellus*				*E.fetida*			
	C (%)	N (%)	P (%)	K (%)	C (%)	N (%)	P (%)	K (%)
1	24.88	1.89	0.18	0.13	23.66	1.70	0.20	0.10
2	25.87	2.02	0.19	0.10	23.19	1.82	0.24	0.12
3	24.65	2.09	0.15	0.09	24.54	1.79	0.21	0.10
4	21.54	1.86	0.12	0.10	22.91	1.89	0.19	0.11
5	24.46	1.82	0.13	0.11	23.46	2.01	0.30	0.10
6	26.55	1.90	0.17	0.08	23.43	1.79	0.21	0.12
7	24.64	1.87	0.25	0.12	22.98	1.75	0.17	0.09
8	26.23	1.75	0.22	0.10	24.36	1.85	0.15	0.12
9	24.84	1.79	0.15	0.11	24.73	1.62	0.19	0.09
10	25.09	1.86	0.21	0.09	23.35	1.75	0.12	0.09

CONCLUSIONS

Based on the results of the study, it is concluded that both earthworms have no significant different in their growth rates. It means that the worms can be used as vermicomposting agent of broiler farm waste. The nitrogen retention and metabolizable energy of the worms were not differing significantly, so that the worms can be used as interchangeable broiler feed. Finally, the result of study indicated that earthworm species did not provide significant effect on the C/N ratio, nitrogen, phosphorus, and potassium contents of the resulted composts. Since those organic matter contents were above the minimum requirement for organic compost of National Standardization of Indonesia, the composts were suitable to be used as single source of fertilizer.

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REFERENCES

[1] Aira, M. F. Monroy, J. Domínguez. : C to N ratio strongly affects population structure of Eisenia fetida in vermicomposting systems. European Journal of Soil Biology ,2006, 42: S127–S131.

[2] Anggorodi. Poultri Feed Scirnce. UI Press. Jakarta. 1985.

[3] Appelhof, M. Worms. Eat My Garbage. 2 nd Ed. Flower Press. Kalamazoo. Michigan.,1982.

[4] CSIRO. Composting: Making Soil Improver from Rubbish. Discovering Soil No.3. 1997.

[5] Daghir, N. J. Poultry Production in Hot Climate. AT University Press. Cambridge. 1995.

[6] Kurnani, T.B.A, Y.A. Hidayati, N. Abdullah, and A. Sutendy. The effect of *Lumbricus rubellus* seedling density on earthworm biomass and quantity as well as quality of Kascing in vermicomposting of cattle feces and bagasse mix. Lucrari Stiintifice Seria Zootehnie. 2010. vol 53 (15): 158 – 163.

[7] National Standardization Agency of Indonesia.. Specification of compost made from domestic organic waste..SNI No. 19-7030- 2004.

[8] Pius M. Ndegwa, S.A. Thompson : Effects of C-to-N ratio on vermicomposting of biosolids. Bioresource Technology, 2000, 75 :7- 12

[9] Wahju. J. Poultry Nutrient Science. Gajah Mada Press. Jogjakarta. 1992.

[10] Waluyo. D. The Effect of Calsium on Body and Clitellium Development, Protein and Amino Acid Content of *Eisenia foetida savigny*. Faculty of Mathematics and Natural Scicence. Bogor Agriculture Institute. Bogor. 1993.