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Research Article

Effectiveness of Various Types of Bio-Activators to Quality of Compost Fertilizer

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Abstract

Background and Objective: Plant litter or plants that grow naturally and the plant materials of the cultivated plants are quite abundant both in fresh and dry form. In the case of a plant, litter is not processed and left on the surface of the soil as organic material then the process of decomposition and reshuffle requires a long time. The research aimed to find out the effectiveness of bio-activators on the formation and quality of compost fertilizer. **Materials and Methods:** The study design was used in a factorial pattern with two factors. The First factor is bio-activator consists of four levels, namely: EM-4, PROMI, Orgadec and (EM-4+PROMI+Orgadec). The second factor is organic matter consists of seven levels, namely: *Imperata cylindrica*, paddy straw, *Gliricidia sepium* leaves, (*Imperata cylindrica* + paddy straw), (*Imperata cylindrica* + *Gliricidia sepium* leaves), (paddy straw + *Gliricidia sepium* leaves), (*Imperata cylindrica* + paddy straw + *Gliricidia sepium* leaves). There were 28 treatments, each treatment was repeated three times to obtain 84 treatment units. **Results:** The result showed that compost fertilizer with Orgadec bio-activator treatment and PROMI is the best quality (pH compost, water content, P-total, N-total, C-organic, C/N ratio). **Conclusion:** The compost fertilizer with Orgadec bio-activator is the best quality for this research (pH compost, moisture content, P-total, N-total, C-organic, C/N ratio).

Key words: Bio-activator, compost fertilizer, *Imperata cylindrica*, *Gliricidia sepium*, paddy straw, cellulose-degrading enzymes, humic acid

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Composting is a method of organic waste management that aims to reduce and change the composition of waste into useful products. According to Barrena *et al.*¹, composting is one of the most environmentally friendly technologies. Compost is defined as organic material that has been stabilized and transformed into a product that is similar to the humic substances in soil². Furthermore, in the case of plant litter is not processed and left on the surface of the soil as organic material then the process of decomposition and reshuffle requires a long time. It is necessary to pre-treat these wastes before their disposal into the soil to avoid any kind of environmental problems³. Improving and maintaining soil quality and fertility in a sustainable way is thus an important challenge for modern agriculture⁴.

The characteristics of the facilities and their respective treatment processes can also affect the compost quality⁵. Following the last trend of environmental policies, composting is a valuable way of waste treatment that contributes to reduce organic waste destined to landfill disposal or incineration⁶, landfilling, or co-evacuation with wastewater⁷. Therefore, there is a need to develop strategies, besides the use of crop residues, to assure the return of the organic matter that is gradually consumed and oxidized in cultivated areas⁸. Orgadec bio-activator can reduce the C/N ratio quickly and are antagonistic to several types of root fungal diseases. Finished compost should be stable and mature, two terms that are often used interchangeably, so it can be safely packaged and transported and not cause adverse effects during its end use⁹.

The novelty of this research lies in testing the effectiveness of three types of bio activators against the decomposition of three types of organic matter, namely: (1) The combination treatment of two and three types of bio activators does not support each other, instead, there is competition for food sources and kills each other between microorganisms so that the decomposition process does not occur, (2) It is recommended to make compost using one type of bio activator, (3) Making compost using organic materials that contain high lignin using the orgadec bio activator. The organic matter of *Imperata cylindrica*, rice straw, *Gliricidia sepium* has great potential to be used as an organic fertilizer because they contain high levels of Nitrogen, Phosphorus and Potassium and are still abundant in the farming community. An accelerating the composting process, the use of these bio activators can increase the quality of the compost. Increasing the quality of compost can improve and increase soil fertility in Ultisols soils in Southeast Sulawesi.

The current study aims to use various bio activators to determine which bio-activators work effectively on the formation of compost fertilizer and to know bio-activators that produce the quality of compost.

MATERIALS AND METHODS

Time and location: The research conducted under net house conditions in District Kambu, Kendari City from February-May, 2019.

Experimental setup: The study design was used in a factorial pattern with two factors. The First factor is bio-activator consists of four levels, namely: EM-4, PROMI, Orgadec and (EM-4+PROMI+Orgadec). The second factor is organic matter consists of seven levels, namely: *Imperata cylindrica*, paddy straw, *Gliricidia sepium* leaves, (*Imperata cylindrica* + paddy straw), (*Imperata cylindrica*+ *Gliricidia sepium*leaves), (paddy straw + *Gliricidia sepium*leaves), (*Imperata cylindrica*+ paddy straw + *Gliricidia sepium* leaves). There were 28 treatments each treatment was repeated three times to obtain 84 treatment units. The mixing compost fertilizer ingredients with the percentage as shown in Table 1.

Composting procedure: The procedure for making compost fertilizer uses the aerobic method. The aerobic method produces CO₂, water and heat. During the fermentation process, there is a change caused by the results of the fermentation process of compost material and the breakdown of cellulose to CO₂ and water or CH₄ and H₂, in addition to the decomposition of proteins into ammonia. The aerobic fermentation process is the process of decomposing organic material using O₂. The result of aerobic fermentation is a product of biological metabolism in the form of CO₂, H₂O, heat, nutrients and some hummus. Making compost fertilizer is as follows: (1) The organic material used is chopped as small as possible with a diameter of ± 5 cm, (2) Organic material+manure each treatment put in a plastic bag, (3) Bio-activator each treatment+enough water stirred until blended, then watered in a pile of compost until the material is moist, (4) Plastic bags are closed however air circulation is provided, then stored in a place that is protected from rain and direct sunlight, (5) Stirring the compost stack every 5 days to avoid temperatures that are too high and too low and (6) Finished compost fertilizer is characterized as follows the temperature is close to the initial temperature of making compost brownish-black, the basic material is no longer visible, it smells like the smell of the soil.

Table 1: Mixing compost fertilizer ingredients

Treatments	Ingredients
KAE	<i>Imperata cylindrica</i> (94.90%)+EM-4 (0.10%)+cow manure (5%)+5 L water
KJE	Paddy straw (94.90%)+EM-4 (0.10%)+cow manure (5%)+5 L water
KDE	<i>Gliricidia sepium</i> leaves (94.90%)+EM-4 (0.10%)+cow manure (5%)+5 L water
KAJE	<i>Imperata cylindrica</i> (47.45%)+paddy straw (47.45%)+EM-4 (0.10%)+cow manure (5%)+5 L water
KADE	<i>Imperata cylindrica</i> (47.45%)+ <i>Gliricidia sepium</i> leaves (47.45%)+EM-4 (0.10%)+cow manure (5%)+5 L water
KJDE	Paddy straw (47.45%)+ <i>Gliricidia sepium</i> leaves (47.45%)+EM-4 (0.10%)+cow manure (5%)+5 L water
KAJDE	<i>Imperata cylindrica</i> (31.63%)+paddy straw (31.63%)+ <i>Gliricidia sepium</i> leaves (31.63%)+EM-4 (0.10%)+cow manure (5%)+5 L water
KAP	<i>Imperata cylindrica</i> (94.95%)+PROMI (0.05%)+cow manure (5%)+5 L water
KJP	Paddy straw (94.95%)+PROMI (0.05%)+cow manure (5%)+5 L water
KDP	<i>Gliricidia sepium</i> leaves (94.95%)+PROMI (0.05%)+cow manure (5%)+5 L water
KAJP	<i>Imperata cylindrica</i> (47.47%)+paddy straw (47.47%)+PROMI (0.05%)+cow manure (5%)+5 L water
KADP	<i>Imperata cylindrica</i> (47.47%)+ <i>Gliricidia sepium</i> leaves (47.47%)+PROMI (0.05%)+cow manure (5%)+5 L water
KJDP	Paddy straw (47.47%)+ <i>Gliricidia sepium</i> leaves (47.47%)+PROMI (0.05%)+cow manure (5%)+5 L water
KAJDP	<i>Imperata cylindrica</i> (31.64%)+paddy straw (31.64%)+ <i>Gliricidia sepium</i> leaves (31.64%)+PROMI (0.05%)+cow manure (5%)+5 L water
KAO	<i>Imperata cylindrica</i> (93.75%)+Orgadec (1.25%)+cow manure (5%)+5 L water
KJO	Paddy straw (93.75%)+Orgadec (1.25%)+cow manure (5%)+5 L water
KDO	<i>Gliricidia sepium</i> leaves (93.75%)+Orgadec (1.25%)+cow manure (5%)+5 L water
KAJO	<i>Imperata cylindrica</i> (46.87%)+paddy straw (46.87%)+Orgadec (1.25%)+cow manure (5%)+5 L water
KADO	<i>Imperata cylindrica</i> (46.87%)+ <i>Gliricidia sepium</i> leaves (46.87%)+Orgadec (1.25%)+cow manure (5%)+5 L water
KJDO	Paddy straw (46.87%)+ <i>Gliricidia sepium</i> leaves (46.87%)+Orgadec (1.25%)+cow manure (5%)+5 L water
KAJDO	<i>Imperata cylindrica</i> (31.24%)+paddy straw (31.24%)+ <i>Gliricidia sepium</i> leaves (31.24%)+Orgadec (1.25%)+cow manure (5%)+5 L water
KAEPO	<i>Imperata cylindrica</i> (94.54%)+EM-4 (0.033%)+PROMI (0.016%)+Orgadec (0.416%)+cow manure (5%)+5 L water
KJEPO	Paddy straw (94.54%)+EM-4 (0.033%)+PROMI (0.016%)+Orgadec (0.416%)+cow manure (5%)+5 L water
KDEPO	<i>Gliricidia sepium</i> leaves (94.54%)+EM-4 (0.033%)+PROMI (0.016%)+Orgadec (0.416%)+cow manure (5%)+5 L water
KAJEPO	<i>Imperata cylindrica</i> (47.27%)+paddy straw (47.27%)+EM-4 (0.033%)+PROMI (0.016%)+Orgadec (0.416%)+cow manure (5%)+5 L water
KADEPO	<i>Imperata cylindrica</i> (47.27%)+ <i>Gliricidia sepium</i> leaves (47.27%)+EM-4 (0.033%)+PROMI (0.016%)+Orgadec (0.416%)+cow manure (5%)+5 L water
KJDEPO	Paddy straw (47.27%)+ <i>Gliricidia sepium</i> leaves (47.27%)+EM4 (0.033%)+PROMI (0.016%)+Orgadec (0.416%)+cow manure (5%)+5 L water
KAJDEPO	<i>Imperata cylindrica</i> (31.51%)+paddy straw (31.51%)+ <i>Gliricidia sepium</i> leaves (31.51%)+EM4 (0.033%)+PROMI (0.016%)+Orgadec (0.416%)+cow manure (5%)+5 L water

K: Compost, A: *Imperata cylindrica*, J: Paddy straw, D: *Gliricidia sepium*, E: E-M4, P: Promi, O: Orgadec

Observation variable: The observed variables include, pH compost, humic acid, fulvic acid, water content, P-total, N-total, C-Organic and C/N ratio.

Data analysis: The quality testing of compost fertilizer (pH compost, humic acid, fulvic acid, water content, P-total, N-total, C-Organic and C/N ratio) is done when the compost fertilizer is ready to use. The compost pH value by the method (pH-meter) and using the spectrophotometric method for humic acid value, fulvic acid, the P-total value, the N-total value, the value C-organic and moisture content by the gravimetry method. The quality testing of compost fertilizer (pH compost, humic acid, fulvic acid, water content, P-total, N-total, C-Organic and C/N ratio) is done when the compost fertilizer is ready to use. The compost pH value by the method pH-meter, the humic acid, fulvic acid, P-total, N-total, C-Organic value by the method spectrophotometric, the water content value by the method gravimetri⁹.

RESULTS

The average quality of compost fertilizer; compost pH, humic acid, fulvic acid and water content listed in Table 2 and P-total, N-total, C-organic and C/N ratio listed in Table 3.

DISCUSSION

Observed quality parameters for compost fertilizer as follows compost pH, humic acid, fulvic acid, water content, P-total, N-total, C-organic and C/N ratio. Compost use is one of the most important factors, which contribute to increased productivity and sustainable agriculture. In addition, compost can solve the problem faced by farmers with decreasing fertility of their soil. Due to soil fertility problems, crop's return often decreases and the crops are more susceptible to pests and disease because they are in bad condition. Compost consists of the relatively stable decomposed organic materials resulting from the accelerated biological degradation of organic materials under controlled, aerobic conditions¹⁰.

The average pH of compost (Table 1), the bio-activator treatment of PROMI and Orgadec is neutral in the range (6.96-7.45). Ideally, the pH of the compost is caused by the microorganisms of the two bio-activators that having the ability to make changes. The treatment of three bio-activators (EM-4+PROMI+Orgadec) rather acidic ranged between 6.17-6.25. There are different phases of the composting process such as mesophilic, thermophilic, cooling and maturation¹¹. The pH of compost material is acidic at the

Table 2: Average results of quality analysis of compost fertilizer (compost pH, humic acid, fulvic acid and water content)

Treatments	Observed			
	Compost pH	Humic acid (mg g ⁻¹)	Fulvic acid (mg g ⁻¹)	Water content (%)
KAE	6.43	35.76	172.83	25.30
KJE	6.42	33.80	170.40	21.70
KDE	6.41	26.29	154.29	20.13
KAJE	6.42	34.62	167.06	21.14
KADE	6.40	29.06	160.84	20.01
KJDE	6.42	28.90	163.93	21.03
KAJDE	6.44	25.04	163.31	21.11
KAP	7.13	43.82	193.79	16.40
KJP	6.96	40.64	189.09	16.05
KDP	7.11	28.43	170.95	17.78
KAJP	7.03	41.87	181.07	16.18
KADP	6.97	36.65	174.16	16.85
KJDP	7.12	35.98	180.88	17.62
KAJDP	7.30	34.75	182.31	16.66
KAO	7.14	46.34	199.38	15.23
KJO	7.17	43.00	194.09	15.19
KDO	7.24	35.76	175.45	15.64
KAJO	7.14	44.80	187.32	16.15
KADO	7.23	39.26	180.95	16.46
KJDO	7.16	37.62	185.03	15.45
KAJDO	7.45	36.76	190.06	16.56
KAEPO	6.17	30.77	164.45	50.86
KJEPO	6.21	26.62	160.98	52.78
KDEPO	6.19	20.15	147.82	53.35
KAJEPO	6.18	31.68	154.15	53.94
KADEPO	6.20	25.16	149.20	53.17
KJDEPO	6.17	26.73	152.06	51.64
KAJDEPO	6.25	22.68	150.67	52.27

K: Compost, A: *Imperata cylindrica*, J: Paddy straw, D: *Gliricidia sepium*, E: E-M4, P: Promi, O: Orgadec

beginning of fermentation this is due to acid-forming bacteria that lower the pH so that compost is more acidic. An experimental study was carried out successively to determine some of the chemical properties of different compost types. The obtained results indicate that the pH value ranged from 6.3-7.8¹². Furthermore, microorganisms begin to convert inorganic nitrogen into ammonium so that the pH rises rapidly to become alkaline.

The orgadec bio-activator treatment with organic matter *Imperata cylindrica* (KAO) had the highest humic acid (46.34 mg g⁻¹) and fulvic acid (199.38 mg g⁻¹) (Table 1). The high content of humic acid and fulvic acid, due to the organic material used in making compost is *Imperata cylindrica* leaves which have high cellulose and lignin content. The more cellulose and lignin content in an organic material the more humic and fulvic acid contents are in line with the decomposition process of the organic material. Treatment KDEPO had the lowest humic acid content (20.15 mg g⁻¹) and fulvic acid (147.82 mg g⁻¹), this was due to the organic material used *Gliricidia sepium* leaves which had low cellulose and lignin content. Besides, the treatment of three bio-activators causes microorganisms in the compost

stack to increase as well, but this capacity of the compost material still causes the lack of food ingredients available for microorganisms to metabolize. This causes competition between microorganisms which will eventually cause the death of some of these microorganisms. According to Rebollido *et al.*¹³, the redistribution of populations to a degree of dominance and the development of stable forms of microorganisms preserve the diversity of species in the structure of the community and signify structural-functional changes.

The average water content (Table 1), bio-activator EM-4, PROMI and Orgadec ranged between 15.19-25.63%. The low water content is due to microorganisms in the compost stack working effectively and the occurrence of high evaporation so that the water content in the bokashi will be reduced. Decreased water content in aerobic composting occurs because the water content in compost material evaporates due to heat, stirring and consumption of microorganisms to convert proteins into nutrients needed by plants. Water content in the treatment of three bio-activators (EM-4+PROMI+Orgadec) is high, ranging between 50.86-53.94%. The high water content is caused by microorganisms that not

Table 3: Average of results quality analysis of compost fertilizer (P-total, N-total, C-organic and C/N ratio)

Treatments	Observed			
	P-total (%)	N-total (%)	C-organic (%)	C/N ratio
KAE	0.74	0.68	31.15	45.81
KJE	0.60	0.63	30.11	47.79
KDE	0.56	0.64	30.85	48.20
KAJE	0.53	0.72	27.52	38.22
KADE	0.57	0.69	29.12	42.20
KJDE	0.52	0.73	30.51	41.79
KAJDE	0.85	0.75	30.18	49.47
KAP	1.20	0.92	24.79	24.77
KJP	0.79	0.90	22.06	24.51
KDP	1.21	1.18	22.40	18.98
KAJP	0.84	1.05	21.70	20.67
KADP	1.22	1.08	24.28	22.48
KJDP	0.81	1.13	23.11	20.45
KAJDP	1.33	1.38	23.76	17.22
KAO	1.60	0.99	20.05	20.25
KJO	0.93	0.97	20.11	20.73
KDO	1.51	1.43	20.96	14.65
KAJO	0.97	1.17	19.09	16.32
KADO	1.49	1.24	22.49	18.14
KJDO	0.98	1.35	19.05	14.11
KAJDO	1.73	2.10	21.79	10.38
KAEPD	0.41	0.46	36.82	80.04
KJEPD	0.47	0.51	35.19	69.00
KDEPD	0.42	0.50	36.61	73.22
KAJEPD	0.43	0.48	36.70	61.17
KADEPD	0.50	0.49	34.63	70.67
KJDEPD	0.47	0.47	36.71	78.11
KAJDEPD	0.56	0.57	35.26	82.00

K: Compost, A: *Imperata cylindrica*, J: Paddy straw, D: *Gliricidia sepium*, E: E-M4, P: Promi, O: Orgadec

working effectively so that evaporation is reduced in the compost pile. These research results are corroborated by Makan *et al.*¹⁴, that's moisture content affects microbial activity, as well as the physical structure, in the composting process and thus has a central influence on the biodegradation of organic materials.

The average P-total (Table 2), orgadec bio-activator AJDO treatment had the highest P-total content around 1.73%. The increased P-total content is due to microorganisms in the orgadec bio-activator working faster so that the metabolism of microorganisms produces phosphate minerals. The increase in phosphorus levels is thought to be an impact of the activity of microorganisms that convert glucose in organic matter into lactic acid so that the environment becomes acidic which causes phosphates bound in long chains to dissolve in organic acids produced by microorganisms. Treatment of three bio-activators (EM-4+PROMI+orgadec) with the lowest P-total content ranged from 0.41-0.56%, this is due to the increasing number of microorganisms in the compost and causes high competition among microorganisms in fighting over food sources¹⁵.

The average N-total (Table 2), orgadec bio-activator BAJDO treatment showed a high total N-content of 2.1%. The high N-total is due to the faster process of composting, so the total value of inorganic N in NH_4^+ and NO_3^- compounds as a result of the fermentation process of organic matter (protein) will also increase. For three bio-activator treatments (EM-4+PROMI+Orgadec), the lowest N-total ranged between 0.41-0.56%, this is due to the competition between microorganisms in the compost stack so that the fermentation process does not go smoothly. The length of the fermentation, the bokashi loses N in the form of NH_3^- which evaporates into the air or is lost through volatilization as ammonia. According to Richard *et al.*¹⁶, the air-filled porosity of composting materials can be predicted from relatively simple measurements of bulk density, moisture and organic matter content. With one set of measurements, the effects of changing moisture and packing density on air-filled porosity follow well-defined relationships¹⁷.

The average C-organic (Table 2), bio-activator EM-4, PROMI and orgadec treatments ranged from 19.09-31.15%. The optimum C-organic content is due to the maximum

working bio-activator so that it can quickly composting the organic matter. The treatment of three bio-activators (EM-4+PROMI+Orgadec) produced the highest C-organic content which ranged between 34.63-36.82%. The high C-organic is due to a large number of microorganisms in the compost heap with a limited number of food sources, causing competition between microorganisms, microorganisms break down carbon compounds as a source of energy in conducting the composting process. According to Makan *et al.*¹⁴, the organic matter was mineralized after composting, mainly due to the degradation of easily degradable compounds, which are used by microorganisms as a source of carbon and nitrogen.

The average C/N Ratio (Table 2), Orgadec bio-activator treatment ranges between 10.38-20.25. Decreasing the content of the C/N ratio in Orgadec bio-activators is caused by microorganisms that working optimally, so that they make an immediate decomposing on organic matter, resulting in carbon loss due to the evaporation of CO₂. Commonly the total C-organic concentration decreases gradually during the fermentation process this is caused by the release of carbon dioxide through the respiration of microorganisms. The treatment of three bio-activators (EM-4+PROMI+Orgadec) produced the highest C/N ratio which ranged between 61.17-82.00, this shows the range of compost fertilizer seems not ideal due to competition between microorganisms, so it does not work optimally in decomposing process. Ahn *et al.*¹⁵, that's a typical completely mixed organic waste composting process these factors are controlled by varying ingredient mix ratios, aeration, turning frequency and occasionally by moisture addition. To speed up the composting process and improve the quality of compost, it is recommended to use an Orgadec bio activator because it was contained microorganisms that can work effectively in the decomposition process and produce quality compost.

CONCLUSION

The compost fertilizer with Orgadec bio-activator is the best quality that meets INS Quality: 19-7030-2004 (pH compost, moisture content, P-total, N-total, C-organic, C/N ratio). Quality compost when applied to infertile soil can improve physical, chemical and biological properties so that soil fertility increases. With increasing soil fertility, plant growth and production will also increase.

SIGNIFICANCE STATEMENT

This research discovers that's quality of compost fertilizer; compost pH, humic acid, fulvic acid, water content, P-total,

N-total, C-organic and C/N Ratio meets INS Quality:19-7030-2004. This study will help the researcher to understand the role of INS Quality:19-7030-2004 as a standard on the quality of compost fertilizer.

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