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ORIGINAL RESEARCH

Evaluation of composting of several plant biomass wastes with different types of starters

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Abstract

Purpose: This study aimed to evaluate the effectiveness of starters made from cattle rumen and EM 4 on the decomposition of agricultural biomass wastes (rice straw, corncobs, and coffee husks).

Method: Three types of starter i.e. starter from local cattle rumen (grass/straw feed), starter from the rumen of cattle farms (concentrate feed), EM 4 (factory product), and control (water) applied to three types of biomass waste (rice straw, corncob, and coffee husk) to observe the decomposition process using the litterbag method. An evaluation was carried out on the rate of decomposition of biomass. Parameters evaluated include decomposition rate, C and total-N content, as well as the C/N ratio.

Results: The starter made from the rumen of grass-fed cows could decompose rice straw and coffee husks at an average that was not significantly different from using EM 4 starter with the speed ratio (k=-0.0852 vs. k=-0.0924) and (k=-0.0832 vs k=-0.0908) respectively. In corncobs, the decomposition speed with a starter of the rumen of cattle farms-concentrate feed was not significantly different from using EM 4 (k=-0.0916 vs. k=-0.1067). The decrease in the C/N ratio is also in line with the decomposition process and was faster with the adding of the starter.

Conclusion: The starter made from the rumen of local cattle (grass feed) and from company cattle (concentrate feed) could decompose plant biomass waste (rice straw, corncobs, and coffee husks) with an average speed that was not significantly different from a starter from factories (EM 4).

Keywords: Starter of cattle rumen, Decomposition rate, Rice straw, Corncob, Coffee husk

Introduction

Crops such as rice and corn are seasonal crops which are widely planted as the major food source in Indonesia. The potential of rice straw was up to 100 million tons annually and over 60% of the amount of straw burned in farmers' fields (Anshar et al. 2015). Corncob is the essential by-product in corn production, which accounts for about 15% of the total mass (Igathinathane et al. 2010). Compared with corn stalk, corncob had better field decomposition charac-

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teristics and excellent application prospects. The total corn production in Indonesia in 2021 was 23 million tons (BPS 2021). According to Kalsum (2018), approximately 30% of corn waste is corncobs, resulting in 6.9 million tons of corncobs in 2021. Some of the rice straw and corncob are used as animal feed. However, there is still much left that is not utilized by farmers.

Besides rice and corn, coffee is also an important commodity in Indonesia, with an average production of between 2014-2018 was 662.75 thousand ton per year (Fitriani et al. 2021). Coffee pulp and husky are the first by-products of the industrial process. They account for 29% and 12% of the dry weight of the overall coffee cherry, respectively, depending on the processing method, either wet or dry. The compositional percentage of dried mature fruits is outer skin (7-8%), pulp/husk (41%), coffee bean (50%), and silver skin (1.2%) (Janissen and Huynh 2018). Some coffee husks are also used as animal feed.

Biomass waste is available from the sum of crop production, agricultural waste, vegetation, and forestry waste (Vaish et al. 2022). Some of the crops' biomass waste is used for animal feed, but much of it is usually burned. In fact, many studies have reported that returning crop residues as compost has benefits on the improvement of soil quality, improve soil microbial, and remediation of soil contamination (Zhao et al. 2019; Li et al. 2021; Fu et al. 2021), including improving the physio-chemical properties of sandy soil (Abdeen and EL-Sayed 2021).

The type of plant and the contents in it influences decomposition rate and enzymatic activities (Berrier et al. 2014; Cordovil et al. 2017; da Costa et al. 2018). Biomass waste materials with a high amount of soluble compounds are metabolized rapidly by any group of microorganisms. By contrast, very specific groups of microorganisms can only degrade slowly organic residues with high structural compounds (cellulose and lignin) (Said-Pullicino et al. 2007; Abril et al. 2011).

To speed up the composting process of plant biomass waste, it is necessary to add a starter (decomposer) to stimulate the decomposition process because it contains bacteria and enzymes. Such as the use of local decomposers, which gave a higher composting rate and percentage of reduction in compost mass than the control (Muliarta et al. 2019). Further, Sudeshna et al. (2021) reported that rice straw plus microbial consortia recorded 12.5% higher residue decomposition than rice residue only.

Although extensive studies on compost production from biomass waste have been reported, but research using compost starter from cattle rumen is limited. The rumen is a complex ecosystem in which nutrients digested by microorganisms such as bacteria, protozoa, and fungi are anaerobically (Chaudhary et al. 1995; Castillo-González et al. 2014). About two-thirds of feed digestion and 90 percent of fiber digestion take place in the rumen, all associated with microbes. The results of the isolation and identification studies showed that the fresh cow dung slurry could contain 106 anaerobic bacteria, 105 coliform bacteria, 106 enterococci bacteria, and 105 fungi per ml of suspension (McCalla et al. 1977). The type and quality of cattle feed influences rumen microbes. As reported that dietary protein level affects the rumen microbial diversity and the ruminal abundance of total bacteria, anaerobic fungi, methanogens, and most of the cellulolytic bacteria considered (Belanche et al. 2012). Because cellulose is the important component of the cell wall of these plants, cellulolytic ruminal microorganisms play an important role in animal nourishment (Russell et al. 2009). In fact, cellulose is digested in the rumen (Michalet-Doreau et al. 2002). The ability to degrade cellulose depends mainly on the type of forage, crop maturity, and the members of the cellulolytic bacterial.

The litter-bag technique has become common in the estimation of the rates of decomposition, in which the mass of litter incubated in mesh bags, which measured over time, and the bags are incubated for only a short period (Prescott 2005; Moore et al. 2017). The litter-bag method has also been widely used to study the rate of decomposition of crops' biomass residues, i.e. maize stover, corncob, rice straw, wheat residues (Lupwayi et al. 2004; Kriauciuniene et al. 2012; Weyers and Spokas 2014). In essence, that negative exponential decay curves, which allow long-term prediction of short-term decay rates, are often used to show the litter mass loss rates (Prescott 2005).

Therefore, this study aimed to evaluate the effectiveness of three types of starters: starter of local cattle rumen (grass/straw feed), starter of cattle farm rumen (concentrate feed), and the starter of factory product (EM 4) on the decomposition rate of agricultural biomass waste, in this case, rice straw, corncobs, and coffee husks.

Materials and methods

This study was conducted in Lampung Assessment Institute for Agricultural Technology experimental field in Natar Village, South Lampung, Indonesia (-5^{0}32'18"; 105^{0}17'66"; 129,9m) from March to August 2022. The soil type was Ultisol with chemical properties as follows: pH 5.23; Organic-C 1.29%; Total-N 0.09%; P_2O_5 (Bray-1) 15.22 mg/kg, and cation exchange capacity (CEC) 6.25 cmol/kg.

Materials

Make a starter from cattle rumen

This study used two types of rumen, the first rumen from local cattle which were fed grass/forage waste, and the second rumen from cattle which fed concentrates. About 5 kg of the beef rumen, 2 kg of rice bran, and 1 kg of molasses were poured into a container containing 15 liters of water and stirred until thoroughly mixed. Then close the container tightly and leave for 10 days.

The starter was analyzed for the content of crude fiber, fat, carbohydrates, protein, and rumen ash in the laboratory of Center for Standardization and Industrial Services Bandar Lampung (Table 1).

Table 1. The content of crude fiber, fat, carbohydrates, protein, and ash of cow rumen-grass feed

No	Parameters	Content (%)
1	Ash	10.71
2	Water content	20.28
3	Carbohydrates	3.47
4	Fat	0.36
5	Protein	1.78
6	Crude fiber	7.71

Parameters analyses of starter

The total plate count method is used to estimate the total number of microorganisms (mold, yeast, bacteria) (Moat et al. 2002; Handayani et al. 2021) in each type of starter.

Experimental set up

Three types of crops biomass residue: rice straw, corncob, and coffee skin evenly moistened with three types of starters/decomposer and incubated in a plastic tarp for 48 hours so that the starter liquid seeps into the biomass waste. Three types of starter/decomposer: starter of local cattle rumen (grass/straw feed), starter of the rumen of cattle farms (concentrate feed), and the starter that available in the market (EM 4), and as a comparison (control) was water. The litterbag method was used to observe the decomposition process and to estimate the rate of biomass decay at a certain time. The fresh biomass from each biomass waste was weighed (100 g of dry weight), then put into a litter bag. The litterbag is a nylon mesh bag with a mesh hole of about 2 mm, with the length x width of 25 cm x 20 cm). The experiment used a completely randomized block design (RBD) with three replications, so the total of the litterbag incubated was 288 (3x4x3x8).

During the decomposition process, the biomass in the litterbag was placed in the soil at a depth of 10 - 20 cm (Fig. 1) and incubated in soil for seven weeks. Every week, several litterbags according to the treatments were taken from the ground, brushed (cleaned of adhering soil), removed biomass from the litterbags, put in a paper bag, and dried in oven at 65ºC 48 hours to convert fresh weight to dry.

Fig. 1 The litterbags were placed in the soil at a depth of 10 - 20 cm

Biomass weight loss and decomposition rate calculation

The percentage of biomass weight loss (X):

$$X = \left(\frac{X_0 - X_t}{X_0}\right) \times 100\%$$

The decomposition rate of biomass waste was calculated using a first-order exponential decay function (Olson 1963) and the simple exponential decay model developed by Rezende et al. (1999); Karberg et al. (2008); and Silva et al. (2008):

$$y = e^{-kt}$$

$$k = \frac{\ln\left(\frac{X}{Xo}\right)}{t}$$

–d[X]/dt = k[X]

d[Xt]/[Xo] = -kdt

∫d[Xt]/[Xo] = -k∫dt

Ln [Xt] = -kt + Ln [Xo]

The value of k (decomposition rate) is obtained from the linear regression analysis with equation Ln [Xt] = -kt + Ln [Xo]

where: Xt is the quantity of dry matter biomass after a period of time t; Xo is the quantity of initial dry matter biomass (100 gr); k= decomposition constant; and t is time.

Parameters analysis of biomass

Total-C and total-N contents were analyzed twice, before incubation and after seven weeks of incubation in the soil. Organic carbon was determined using the Walkley and Black procedure and total nitrogen was determined by the modified Kjeldahl method. C/N ratio was calculated by dividing C (%) with total N (%).

Statistical analysis

The data of decomposition constant (k) were subjected to analysis of variance using SPSS v.18 and least significant difference (LSD) was calculated as a post hoc test to separate the treatment means at a 5% probability level.

Result and discussion

Number of microbes in starter

Based on the total plate count method, the total number of microorganisms in starter of cattle rumen-grass feed has the highest number of microbes, 14.7% more than EM 4, and 85.3% more than starter of cattle rumen-concentrate feed (Table 2). In ruminants fed conventional diets, the type of carbohydrate consumed modifies the rumen microbial population (Fernando et al. 2010). Similar results were reported that the provision of a feed comprising fresh grass (*Pennisetum puerperium*), silage, and concentrate with different compositions affects the number of each type of microbes in the rumen of cattle (Ridwan et al. 2019). While EM 4 is a starter of factory production containing fermenting microbes, including *Rhodopseudomonas sp*, *Actinomycetes sp*, and *Streptomyces sp* (refer to the product label).

Table 2. Total microbes contained in the three types of starters used in this study

No	Type of Starter	Total microbes
1	Cow rumen-grass feed	22.78 x 10^6 CFU/ml
2	Cow rumen-concentrate feed	33.48 x 10^5 CFU/ml
3	EM 4	2.8 x 10^6 CFU/ml[*)]

[*)]Source : PT Songgolangit Persada 2011

Biomass weight loss per week

In the first week, the average weight loss of rice straw, corncob, and coffee husk biomass was higher than in the following weeks. The highest weight loss in rice straw was 22.3% with starter of cattle rumen-grass feed application, while corncob is 15% with starter of cattle rumen-grass feed, and coffee husk is 14.3% with starter of cattle rumen-concentrate feed application in the first week (Table 3). There was less variation in weight loss during the second to fifth week, but faster weight loss in the sixth and seventh week. However, in the seventh week, the average weight of the three types of biomasses reduced to about 50% remaining. Almost the same pattern was reported by Zou et al. (2021) that in the field decomposition of corn cob followed the pattern of first being fast, then slow, and ultimately speeding up gradually. This is related to the decomposition process begins with the oxidation of more easily degradable organic compounds, this phase soluble sugars and starches are broken down by mesophilic microbes (Wichuk and McCartney 2010).

Based on the data in Table 3, the starter application from both the rumen and EM 4 accelerated the weight loss of the three types of composted biomass. Soil conditions also support the activity of decomposing microbes, which play a role in the decomposition of biomass, so the weight loss will increase. Matheus et al. (2013) reported that the highest weight loss of biomass was shown in all embedded biomass compared to those placed on the soil surface.

Decomposition rate of plant biomass wastes with various starter applications

The graph that relates the natural logarithmic regression values of the residual dry weight of biomass after decomposition with various types of starter with incubation time (weeks) can be seen in Fig. 2, 3, and 4, as well as the average rate of decomposition (k) in Table 4 , 5, and 6.

Decomposition rate of rice straw

Rice straw usually takes a long time to decompose because it contains low crude protein, but high crude fiber, lignin, and cellulose content. The initial percentage of cellulose, hemicellulose, and lignin content in the rice straw were 42.2%, 26.4%, and 5.9%, respectively (Yan et al. 2019). Based on Table 4, the application of starter EM 4 in rice straw gave the fastest average decomposition rate, followed by starter of cattle rumen-fed grass, starter of rumen fed-concentrate, and control, respectively. However, the starter made from the rumen of grass-fed cattle could decompose rice straw at an average that was not significantly different from using the EM 4 starter (k=0.0852 vs. k=0.0924) (Table 4).

Table 3. The percentage of biomass weight loss (%) after application several types of starters and incubated in soil with litterbag method during seven weeks

	Weeks							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Treatments	--------------------- Percentage of biomass weight loss (%) ---------------							
Rice straw-control	100	21.0	22.0	27.0	26.3	22.0	33.0	41.7
Rice straw-cattle rumen (grass feed)	100	22.3	27.3	32.4	40.0	39.0	34.0	53.3
Rice straw- cattle rumen(concentrate)	100	21.3	31.7	33.0	40.0	34.0	37.0	51.0
Rice straw-EM 4	100	15.0	26.0	30.3	18.3	28.0	31.0	59.0
Corncob-control	100	9.3	16.7	21.7	26.3	31.7	34.3	32.3
Corncob- cattle rumen (grass feed)	100	15.0	16	19.0	29.3	37.9	37.7	56.0
Corncob- cattle rumen (concentrate)	100	12.0	15.3	23.3	24.0	27.3	45.3	50.0
Corncob-EM 4	100	9.3	15.0	25.3	36.0	39.7	44.4	53.3
Coffee husk-control	100	9.1	1.9	2.7	17.3	24.7	24.3	40.3
Coffee husk-cattle rumen (grass feed)	100	1.3	16.9	17.3	32.3	28.9	36.9	44.4
Coffee husk-cattle rumen (concentrate)	100	14.3	19.7	29.9	27.9	30.3	33.9	47.9
Coffee husk-EM 4	100	9.3	15.9	30.3	31.7	37.7	31.9	52.9

EM 4 is a starter (decomposer) with a brand that available in the market around the research location. The microbes in the EM 4 accelerate the fermentation of organic matter into easily absorbed organic compounds by plant roots. Based on the label, EM 4 contains fermenting and synthetic microorganisms comprising lactic acid bacteria (*Lactobacillus sp*), photosynthetic bacteria (*Rhodopseudomonas sp*), *Actinomycetes sp*, *Streptomyces sp*, Yeast, and cellulose decomposing fungi. The application of EM 4 starter has been shown to speeds up the composting process of rice straw, as reported by Aye (2016) that the addition of EM 4 to rice straw takes 90 days until complete decomposition, while the control (without EM 4) takes up to 120 days.

Likewise, in the rumen, there are various types of microorganisms, such as bacteria, protozoa, and fungi, are involved in the fermentation of substrates in animal feed (carbohydrates, proteins and lipids). In field, various nutritional supplements are usually applied to meet the needs of cattle rearing and vary by region, season, and stocking intensity which affect the composition of the rumen microbiome.

Symbiotic relationships are found among various groups of microorganisms in the rumen because of the diverse nature of these microbial species and their adaptability in the rumen environment (Castillo-González et al. 2014).

Various factors can affect the composition of the rumen microbiome in cattle, including age and nutrition.

Many microbial species associated with lignin and cellulose degradation were present in the rumen of adult cattle (Flint and Bayer 2008) which can play a role in the degradation of cellulose and lignin in rice straw. Sukaryani et al. (2021) reported that the addition of inoculum microbial cellulolytic and lignocellulolytic decreased the lignin content of biomass and significantly increased rice straw decomposition than control (Sudeshna et al. 2021). Further, Muliarta et al. (2019) concludes that the use of local decomposers gives the composting rate, and the percentage of the rice straw mass reduction is higher than the control.

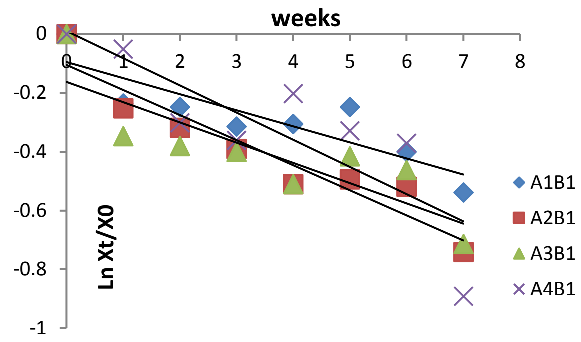

Fig. 2 Regression of natural logarithm of dry weight of remaining rice straw with several types of starters during seven weeks

Table 4. Decomposition rate (k) of rice straw biomass after application of several types of starters and incubated in soil with litterbag method during seven weeks

Codes	Treatments	Regression equations	k
A1B1	Rice straw-control	y=-0.0546x-0.0954	0.0546 c
A2B1	Rice straw-cattle rumen (grass feed)	y=-0.0852x+0.0105	0.0852 a
A3B1	Rice straw-cattle rumen (concentrate)	y=-0.0688x+0.1628	0.0688 b
A4B1	Rice straw-EM 4 decomposer	y=-0.0924x+0.0101	0.0924 a

Means followed by the same letters at each column are not significantly different (P < 0.05; LSD test)

Decomposition rate of corncob

Corncob biomass weight loss is different for each type of starter application (Fig. 3).

The application of starter EM 4 in corn cob biomass gave the fastest average decomposition rate, followed by starter from the rumen of cattle- fed concentrate, starter of rumen cattle-fed grass, and control. Based on the values of the decomposition rate constant (k) in Table 5, EM 4 starter application on corncobs decomposed the fastest during seven weeks of incubation (k=0.1067), followed by starter of rumen concentrate-fed (0.0916), starter of rumen grass-fed (k=0.0823), and control (k=0.0596).

Corncob biomass contains high levels of total C and low nitrogen, so C/N ratio is also high. C/N ratio of corncobs before incubation ranged from 36.65-41.91% and after incubation 18.08-22.49% (Table 7). The results of the previous analysis also showed that corncobs have low protein content (<4.64%), but high cellulose and lignin levels (Ramirez et al. 2007). Thus, the addition of the starter seems to accelerate the decomposition of corncob, especially in the early stages of decomposition, as also shown by the weight loss of corncob biomass in the first week without a starter (control) of only 9.3%, but with a starter of cattle rumen grass feed, the weight loss of biomass increased to 15% (Table 3).

It is known that the rate of decomposition is also affected by the environment in which the biomass is incubated. Like Wienhold et al. (2011) reported that the weight loss of cobs in litterbags buried or placed on the surface after one growing season was 49% of cobs surfaced and 59% of cobs buried in the soil.

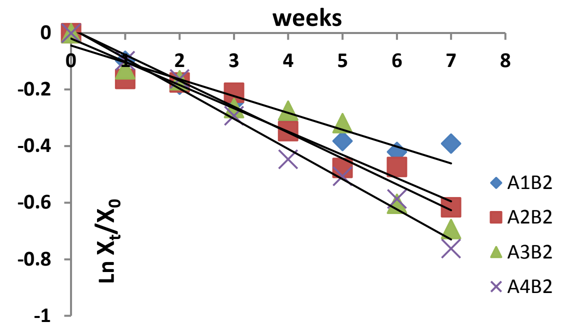

Fig. 3 Regression of natural logarithm of dry weight of remaining corn cob with several types of starters during seven weeks

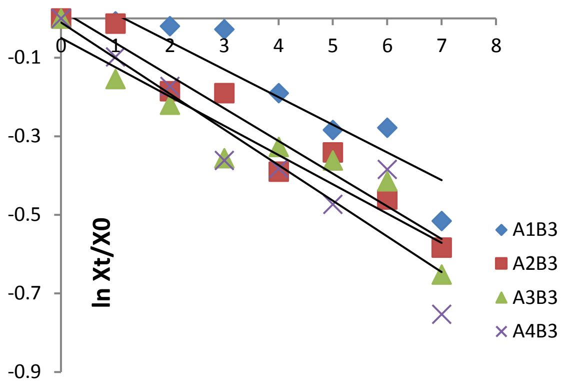

Fig. 4 Regression of natural logarithm of dry weight of remaining coffee skin with several types of starters during seven weeks

Decomposition rate of coffee husk

The weight reduction of coffee husk biomass increased with incubation time and varied depending on the type of starter application (Fig. 4). Coffee husk decomposition was fastest with EM 4 starter, followed by starter from the rumen of cattle-fed grass, rumen of cattle-fed concentrate, and control. However, decomposition rate with starter from the rumen of grass-fed cattle was not significantly different from using the EM 4 starter (k=0.0832 vs. k=0.0908) (Table 6). The microbes in the starter break down organic compounds, such as carbohydrates and proteins, during the fermentation process into simpler compounds. Fresh coffee husk contains high protein (17.8-22.2%) (Gottstein et al. 2021), so the decomposition rate at the initial stage should be faster than rice straw or corncob. Based on Table 6, the values of the decomposition rate of coffee husk without starter (control) is not significantly different from using starter of cattle rumen-concentrate fed. But the starter application will speed up the decomposition process, as Yenani et al. (2021) reported that decomposition of coffee skin is faster because of the use of Pumakkal starter that has 15 types of potential bacteria for decomposer microorganisms.

Characteristics of rice straw, corncob, and coffee husks before and after incubation

The content of C, total N and C/N ratio before and after incubation are shown in Table 7. There was a decrease in the C content, N-Total, and C/N ratio of rice straw, corncob, and coffee husk biomass after seven weeks of incubation compared to before. The decomposition process of biomass lowers carbon content, the highest decrease of the C content of rice straw was with a starter of EM 4 (20.21%). In corn cob, the highest decrease of the C content was with the application of a starter of rumen grass-fed (31.37%). Then, the highest decrease of the C content of coffee husk was with the application of a starter of rumen grass-fed (18.77%) (Table 7). During the decomposition process, carbon was used as an energy source by decomposers while nitrogen was assimilated into a cell as proteins and other compounds. Microbes carry out complete oxidation of carbon sources and convert them into CO_2 and other low molecular weight carbon compounds, so that the carbon content in decomposed organic matter will decrease (Gunina and Kuzyakov 2022).

Table 5. Decomposition rate (k) of corn cob biomass after application of several types of starters and incubated in soil with litterbag method during seven weeks

Codes	Treatments	Regression equations	k
A1B2	Corncob–control	y =-0.0596x-0.0443	0.0596 c
A2B2	Corncob-cattle rumen (grass feed)	y=-0.0823x-0.0196	0.0823 b
A3B2	Corncob-cattle rumen (concentrate)	y=-0.0916x+0.0145	0.0916 ab
A4B2	Corncob-EM 4 decomposer	y=-0.1067x+0.0168	0.1067 a

Means followed by the same letters at each column are not significantly different (P < 0.05, LSD test)

Table 6. Decomposition rate (k) of coffee skin biomass after application of several types of starters and incubated in soil with litterbag method during seven weeks

Codes	Treatments	Regression equations	k
A1B3	Coffee husk-control	y =-0.0704x-0.0815	0.0704 b
A2B3	Coffee husk-cattle rumen (grass feed)	y=-0.0832x-0.0041	0.0832 ab
A3B3	Coffee husk-cattle rumen (concentrate)	y=-0.0745x+0.0496	0.0745 b
A4B3	Coffee husk-EM 4 decomposer	y=-0.0908x+0.0103	0.0908 a

Means followed by the same letters at each column are not significantly different (P < 0.05; LSD test)

Table 7. The content of C, Total N, and C/N ratio of plant biomass before and after incubation in the soil

Treatments	Before incubation			After incubation		
	C (%)	**Total-N (%)**	**C/N ratio**	**C (%)**	**Total-N (%)**	**C/N ratio**
Rice straw-control	35.56	1.45	24.52	23.65	1.42	16.65
Rice straw-cow rumen (grass feed)	38.52	1.46	26.38	21.42	1.42	15.08
Rice straw-cow rumen (concentrate)	40.54	1.68	24.13	21.43	1.24	17.28
Rice straw -EM 4 decomposer	40.46	1.55	26.10	20.25	1.28	15.82
Corncob-control	44.56	1.25	35.65	20.02	0.89	22.49
Corncob-cow rumen (grass feed)	46.94	1.12	41.91	15.57	0.71	21.93
Corncob-cow rumen (concentrate)	42.58	1.02	41.75	16.65	0.79	21.08
Corncob-EM 4 decomposer	42.78	1.05	40.74	15.55	0.86	18.08
Coffee husk-control	39.53	1.72	22.98	25.86	1.56	16.58
Coffee husk-cow rumen (grass feed)	41.18	1.82	22.63	22.41	1.22	18.37
Coffee husk-cow rumen (concentrate)	39.87	2.01	19.84	23.52	1.33	17.68
Coffee husk-EM 4 decomposer	39.86	1.88	21.20	21.21	1.28	16.57

The addition of microbial starter culture is very important to speed up the composting of biomass waste, such as an effective microorganism (EM) to achieve better compost quality and maturity in less process time period (Rastogi et al. 2020). Carbon-Nitrogen ratio (C/N) is commonly used for predicting the relative decomposability of organic materials and as a general index of quality of crop residues (Kumar and Goh 2000; Hueso et al. 2012). The trend of decreasing C/N ratio during the process is associated with a higher ratio of degradation of biomass (carbon) to nitrogen mineralization. Because of the increase in microbial activity, a lot of carbon is released into the air and dissolved nitrogen compounds increase, so that C/N ratio of organic matter decreases. The C/N ratio has often been used to assess the maturity of compost during the decomposition process (Casado-Murillo and Abril 2013).

Conclusion

Starter made from the rumen of cattle, both from local cattle (grass feed) and from company cattle (concentrate feed) was effective in accelerating the decomposition of rice straw, corncob, and coffee husk compared to the control. However, based on the decomposition rate values of rice straw, corncob, and coffee husk got in this study showed that the use of EM 4 starter was more effective than starter made from the rumen of cattle, both local feed and concentrated feed. Therefore, further development is required to isolate and multiply specific types of microbes from the rumen of cattle that plays a role in the decomposition of certain types of plant biomass.

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Compliance with ethical standards

Conflict of interest The authors declare that there are no conflicts of interest associated with this study.

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