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Differences in C/N ratios and nutrient content of N, P, and K, in Making Compost from Rice Straw Waste with Trichoderma sp Activator

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ABSTRACT
This study aims to determine differences in nutrient levels in the manufacture of compost from rice straw waste with Trichoderma sp. activator. to the value of the C/N ratio and the nutrients N, P, K. The superiority of Trichoderma sp. Among others, it is easy to apply, does not produce toxins, is environmentally friendly, does not disturb organisms in the soil and does not leave residues in plants or soil. In making compost in compost tanks, the use of Trichoderma sp with a combination of ash and lime (JKAL) can increase the content of C-Organic, N-Total, Phosphorus and Potassium with respective values of 20.34%, 0.90%, 0 , 40% and 0.40%. The lowest C/N content was shown in the use of Trichoderma sp added with Ash (JAL) which was 22.0. In the treatment of making compost in containers, the use of Trichoderma sp with a combination of ash and lime (JKAD) was able to increase the content of C-Organic, N-Total and Phosphorus and was able to reduce the value of C/N with an average value of 19.8% respectively , 21.67%, 0.18% and 21.67%. The highest average value of Potassium (K) content shown in the JAD treatment was 0.46%.

Keywords *:* Rice Straw, Nitrogen, Phosphorus, Potassium, Trichoderma sp

INTRODUCTION

Rice straw is a lignocellulosic material that is available in large quantities and has not been used optimally in Indonesia. Usually straw is used for animal feed and the rest is left to rot or burn. Rice straw is an agricultural waste that is available in large quantities compared to other agricultural wastes, and is easy to obtain for use as animal feed and partly into compost. One way to overcome the continuous use of chemical fertilizers is by using organic matter in the form of compost. Agricultural solid waste that is allowed to accumulate for a long time will result in various adverse effects, both for health and environmental pollution. Vegetable and fruit waste is a waste material that is usually disposed of in open dumping without further management, which will leave environmental disturbances and an unpleasant odor. Vegetable and fruit waste has low nutritional content, namely 1-15% crude protein and 5-38% crude fiber (Jalaluddin, Nasrul, & Syafrina, 2016

Composting is a sustainable technology because it aims at environmental conservation, human safety, and provides economic value. The use of compost helps environmental conservation by reducing the use of chemical fertilizers which can cause damage to land both chemically, glassy and biologically. Indirectly, composting is an alternative to waste utilization so that the environment is maintained. Composting is the process of decomposing organic matter into compost, in which the compounds present in the organic matter are decomposed. The use of biological agents is very possible to be applied to upland vegetable farmers because antagonistic microbes are easy to develop with media from agricultural waste, easy to apply, and the cost is much cheaper than synthetic pesticides (Syatrawati & Inderiati, 2017).

Soil-dwelling microorganisms that can be isolated from field plant roots. Several

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species of Trichoderma have been reported as biological agents, namely: T. Harzianum, T. Viridae, and T. Koningi which have a broad spectrum on various agricultural crops. Trichoderma mushroom culture in applicable media such as rice bran can be given to planting areas and acts as a biodecomposer that decomposes organic waste into quality compost. It can also act as a biofungicide, in which this fungus can inhibit the growth of several fungi that cause disease in plants, including: Rigidoporus lignosus, Fusarium oxysforum, Rizoctonia solani, Sclerotium rolfsii, etc. (Marianah, 2013)

One of the functional microorganisms that are widely known as a soil biological fertilizer is the fungus Trichoderma sp. Species of Trichoderma sp. besides being a decomposer organism, it can also function as a biological agent and a stimulator of plant growth. Besides that, it can also act as a biofungicide, which plays a role in controlling pathogenic organisms that cause plant diseases (Setyadi, Artha, & Wirya, 2017). Based on this, it is necessary to apply a technology to overcome agricultural solid waste by using solid waste recycling technology into compost products that have high use value and are environmentally friendly. This study aims to determine the levels of nutrients in composting from Rice Straw Waste with Trichoderma sp. Activator

LITERATURE REVIEW

Trichoderma sp., can inhibit the growth of several fungi that cause disease in plants, including Rigidiforus lignosus, Fusarium oxysporum, Rizoctonia solani, Sclerotium rolfsi. Besides its ability as a biological controller, Trichoderma sp. give a positive influence on plant roots, plant growth, crop production. This trait also indicates that Trichoderma sp. acts as a Plant Growth Enhancer (Styadi, Artha, & Wirya, 2017). Trichoderma is one of the widespread (cosmopolitan) soil fungi, which can be found almost in agricultural lands and plantations. Trichoderma is saprophytic on soil, and wood, and some species are parasitic on other fungi.

Trichoderma is cosmopolitan, and can be isolated from soil, grains, paper, textiles, potato rhizosphere, wheat, sugar beet, grass, straw, and wood. Has an optimum growth temperature of 15o - 30o (35o C) and a maximum of 30o - 36o C. Conidiophores can branch like a pyramid, namely at the bottom of the lateral branches that are repeated, while towards the ends the branches become shorter. Conidia are semicircular to short oval in shape (Gandjar et al, 1999). Trichoderma sp. is a fungus that has quite high cellulotic activity, this fungus has a cellulase enzyme consisting of the exogluconase (β-1.4glycanhydrolase) and cellubiase (β-glucosidase) enzymes. Trichoderma sp. is one of the fungi that is able to produce cellulase enzyme components (Irianti & Suyanto, 2016).

METHODS

The materials used in this study were rice straw, a starter solution containing Trichoderma sp., and water for watering the compost heap. The tools used are compost tubs measuring 1 m long, 1 m wide, and 1-1.25 m high as many as 5 pieces, dark-colored plastic measuring 1 m x 5 m and 2 m x 2 m each one sheet, raffia rope to bind compost piles, buckets, dippersThe methodology section typically has the following sub-sections: sampling (description of the target population, research context, and units of analysis; sampling; and respondent profile), data.

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Research design

This research was conducted based on a Completely Randomized Design (CRD) which consisted of 5 treatments and 3 replications and was averaged (Gasperz, 1991). The arrangement is as follows:

P0 = Rice straw + 5% Trichoderma sp
P1 = Rice straw + 5% Trichoderma sp + Lime
P2 = Rice straw + 5% Trichoderma sp fungus + Ash
P3 = Rice straw + 5% Trichoderma sp fungus + Lime + Ash

Making Compost in Tubs

The first layer of rice straw is put into a tub with a pile height of 20-25 cm, then watered to keep it moist. Furthermore, the pile of rice straw was watered with Trichoderma sp. activator solution. evenly per layer. Continue with the second layer and so on until the height of the haystack is about three quarters of the compost bin or 80-90 cm. The tub contains straw that is ready to be composted and then covered with dark colored plastic. After one week, the compost is turned over so that the heat is evenly distributed and the composting takes place perfectly. Composting rice straw with lignocellulolytic microbial activators generally requires a fermentation time of 2 weeks. Compost that has matured will be black-brown in color with a temperature of around 30ºC, humidity of 40-60%, and will not emit an odor. Repeat for other treatments.

Making Compost Without Containers

Compost is made in the corner of a paddy field with a size of 2 m x 5 m or wider, depending on the available rice straw. Straw is piled flat with a height of 20-25 cm in the area that has been marked with stakes, then sprinkled with water and given the activator solution evenly. And so on until the height of the haystack reaches 1.25 m, then covered with dark plastic. One week later the compost is turned over. Reversal is done in stages per layer starting from the top layer to the bottom layer. Repeat for other treatments

The treatment given to the composting process can be seen in Table 1

Table 1. Treatment Code

No	Treatment	Code
1	Rice straw + 5% Trichoderma sp. in the compost bin	JOL
2	Rice straw + 5% Trichoderma sp. + Ashes in the compost tub	JAL
3	Rice straw + 5% Trichoderma sp. + Lime in the compost tub	JKL
4	Rice straw + 5% Trichoderma sp. + Lime + Ash in the compost tub	JKAL
5	Rice straw + 5% Trichoderma sp. in a container	JOD
6	Rice straw + 5% Trichoderma sp. + Ashes in the container	JAD
7	Rice straw + 5% Trichoderma sp. + Chalk in a container	JKD
8	Rice straw + 5% Trichoderma sp. + Lime + Ash in a container	JKAD

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RESULTS AND DISCUSSION

Results

Composting was carried out for four weeks with 2 different treatments, namely making compost in containers and not using containers (in compost tanks). In each treatment, three repetitions were carried out. This is done to find out the nutrients contained in composting, especially the C/N ratio, Nitrogen (N, Phosphorus (P) and Potassium (K)) for the two treatments. So that it can be known which treatment has or

Table 2. Average Value of C-Organic Content (%)

Treatment	C-Organik	SNI quality standard (9.8-32)
JOL	19.60^{ab}	In accordance
JAL	19.93^{bc}	In accordance
JKL	19.70^{bc}	In accordance
JKAL	20.34^{c}	In accordance
JOD	18.47^{a}	In accordance
JAD	19.77^{bc}	In accordance
JKD	$19.^{23ab}$	In accordance
JKAD	19.87^{bc}	In accordance

Note: Different superscripts in the same column show significantly different results at the 5% level according to the DMRT test

The C-Organic content in the two composting treatments produced was included in the appropriate category based on the SNI 19-7030-2004 organic fertilizer quality standards (9.80% -32%). The highest average value of C-Organic content in the treatment of composting in compost tanks was shown in the JCAL treatment, which was 20.34%, and the lowest was shown in the JOL control treatment, which was 19.6%. The same thing happened to the treatment of making compost in containers, the highest average value of C-organic content was shown in the JKAD treatment which was 19.87% and the lowest was shown in the JOD control treatment which was 18.47%. Based on the results obtained, it can be seen that the control treatment which only used 5% Trichoderma fungi had better quality than the other treatments because it had a lower C-organic content than all treatments. Carbon (C) is part of the composition of plant tissues where during the composting process carbon is used as an energy source to compile cellular materials for microbial cells by releasing CO2 and other materials that evaporate. C levels tend to decrease after composting (Amnah & Friska, 2019)

Based on the results of the variance showed that there were differences between treatments. DMRT further test results showed that composting in tubs in the JOL control treatment using only 5% Trichoderma fungi was significantly different from the JAL treatment, but not significantly different from the JAL and JKL treatments. Similarly, for composting in containers, the JOD control treatment was significantly different from the JAD and JKAD treatments, but not significantly different from the JKD treatment. This shows that the addition of ash and lime to straw composting with Trichodherma mushroom decomposer can slow down the rate of decomposition because the C-Organic value is still higher compared to the control treatment without the use of ash and lime. However, when referring to the organic fertilizer quality standard SNI 19-7030-2004 (9.80% -32%), the addition of ash and lime in composting using the Trichodherma mushroom decomposer is still in the category according to the standard.

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Table 3. Average Value of N-total content (%)

Treatment	N-Total	SNI quality standard (0,40)
JOL	0.61[a]	In accordance
JAL	0.81[bc]	In accordance
JKL	0.90[c]	In accordance
JKAL	0.90[c]	In accordance
JOD	0.70[b]	In accordance
JAD	0.86[bc]	In accordance
JKD	0.86[bc]	In accordance
JKAD	0.92[c]	In accordance

Note: Different superscripts in the same column show significantly different results at the 5% level according to the DMRT test

The N-total content in the two composting treatments produced was included in the appropriate category based on the SNI 19-7030-2004 organic fertilizer quality standard (0.40). The highest average value of N-Total content in the treatment of composting in compost tanks was shown in the JCAL treatment, which was 0.90% and the lowest was shown in the JOL control treatment, which was 0.61%. The same thing also happened in the treatment of making compost in containers, the highest average value of N-Total content was shown in the JKAD treatment which was 0.92% and the lowest was shown in the JOD control treatment which was 0.7%. Nitrogen N is used as an energy source by microorganisms in decomposing organic matter, the higher the N element contained in a compost material, the faster the decomposition process can take place. According to (Sofa, Hatta, & Arifin, 2022) Microorganisms need nitrogen levels for the formation and maintenance of body cells.

The higher the nitrogen content, the faster the decomposition of organic matter, because microorganisms that decompose compost need nitrogen for their development. Compost that has a high nitrogen content will be very good for application to plants. Some of the functions of N for plants are stimulating vegetative growth of plants, such as leaves, stems, and roots, increasing plant growth and nourishing leaf growth with a greener color (Nuraeni, Khairani, & Susilawati, 2018). Based on the results of the variance showed that there were differences between treatments. DMRT further test results showed that composting in tubs in the JOL control treatment using only 5% Trichoderma fungi was significantly different from the other treatments, namely the JAL, JKL and JCAL treatments. Meanwhile, there was no significant difference between the JAL, JKL and JCAL treatments.

In making compost in containers there was a significant difference between the JOD control treatment and the JKAD treatment. Meanwhile, there was no significant difference between the JAD, JKD and JKAD treatments. This shows that the addition of ash and lime can increase the total N content in making straw compost

Table 4. Average Value of C/N Ratio

Treatment	C/N	SNI quality standard (10-20)
JOL	32.33[a]	not suitable
JAL	24.67[bc]	not suitable
JKL	22.00[c]	not suitable
JKAL	22.67[c]	not suitable

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JOD	26.33^{b}	not suitable
JAD	23.00^{c}	not suitable
JKD	22.67^{c}	not suitable
JKAD	21.67^{c}	not suitable

Note: Different superscripts in the same column show significantly different results at the 5% level according to the DMRT test

Based on the results obtained, the highest C/N ratio average value for composting in compost tanks was shown in the JOL control treatment, which was 32.33, and the lowest was shown in the Tricodherma + ash (JAL) combination treatment, which was 22.0. almost the same also occurred in the treatment of making compost in containers, the highest average value of the C/N ratio was shown in the control treatment (JOD) which was 26.3. Meanwhile, the lowest C/N ratio was shown in the combined treatment of tricoherma + ash + lime (JKAD) which was 21.67. The C/N ratio in the two composting treatments was all included in the unfavorable category based on the organic fertilizer quality standard SNI 19-7030-2004 (10-20) because the value was above 20. Based on the results of the C/N ratio values in all treatments, it can be said that the compost that has been made has not yet matured because the value of the C/N ratio in all treatments is still above the value of 20. The C/N ratio is an indicator of the quality and maturity level of the compost material.

The degradation process that occurs in composting requires organic carbon (C) for energy and growth, and nitrogen (N) for protein as a building block for metabolic cells. The effective C/N ratio for the composting process ranges from 30-40. Microorganisms break down compound C as an energy source and use N for protein synthesis. At C/N values between 30-40 microbes get enough C for energy and N for protein synthesis. If the C/N value is too high, the microbes will lack N for protein synthesis so that decomposition is slow. Compost with a low C/N ratio will contain a lot of ammonia (NH3) which is produced by ammonia bacteria. These compounds can be further oxidized into nitrites and nitrates which are easily absorbed by plants (Ismayana, Indrasti, Suprihatin, Maddu, & Fredy, 2012).

Based on the results of the variance showed that there were differences between treatments. DMRT further test results showed that composting in tubs in the JOL control treatment using only 5% Trichoderma fungi was significantly different from the other treatments, namely the JAL, JKL and JCAL treatments. Meanwhile, there was no significant difference between the JAL, JKL and JCAL treatments. In making compost in containers there was a significant difference between the JOD control treatment and the JAD, JKD and JKAD treatments. Meanwhile, there was no significant difference between the JAD, JKD and JKAD treatments. This shows that the treatment with the addition of ash and lime in composting can accelerate compost ripening, although in this study none of the treatments showed a C/N ratio that complied with SNI 19-7030-2004 organic fertilizer quality standards.

Table 5. Average Value of Phosphor content (%)

Treatment	Phosphor	SNI quality standard (0,10)
JOL	0.27^{ab}	In accordance
JAL	$0,28^{ab}$	In accordance
JKL	0.27^{ab}	In accordance
JKAL	$0,40^{c}$	In accordance

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JOD	0,23[a]	In accordance
JAD	0,32[b]	In accordance
JKD	0,38[c]	In accordance
JKAD	0,38[c]	In accordance

Note: Different superscripts in the same column show significantly different results at the 5% level according to the DMRT test

The content of Phosphorus (P) in the two treatments for making the resulting compost is in the good category based on the organic fertilizer quality standard SNI 19-7030-2004 (0.10). The highest average value of Phosphorus content in the treatment of composting in compost tanks was shown in the JAL treatment, which was 0.40% and the lowest was shown in the JOL control treatment, which was 0.27%. The same thing also happened in the treatment of making compost in containers, the highest average value of Phosphorus content was shown in the JKAD and JAD treatments, which was 0.38% and the lowest was shown in the JOD control treatment, which was 0.23%. Based on the results obtained, compost made in two places, namely in containers and in compost tubs, can be used as fertilizer to increase plant nutrient levels, especially P nutrient levels. P nutrient is a macro nutrient that is needed a lot by plants but its availability for plants is very low in the ground. In addition, the element P has an important function for plant growth. According to (Aziz, 2013) Phosphorus (P) is an essential macro nutrient which is very important for plant growth, but its content in the soil is lower than nitrogen (N), potassium (K), and calcium (Ca). Phosphorus functions to stimulate root growth and system formation, stimulate flower growth and fruit/seed ripening, and increase plant resistance to pest attacks.

Based on the results of the variance showed that there were differences between treatments. The results of the DMRT follow-up test showed that composting in tubs in the JAL treatment, namely the combination of 5% Trichoderma + Lime + Ash fungi, had a significant difference to the other treatments, namely the JOL, JAL, and JKL treatments. Meanwhile, there was no significant difference between the JOL, JAL, and JKL treatments. In making compost in containers there was a significant difference between the JOD control treatment and the JAD, JKD and JKAD treatments. Significant differences also occurred between the treatment of JAD and JKD and JKAD. Meanwhile, there was no significant difference between the JKD and JKAD treatments. From the results of these statistical tests it can be concluded that the combination treatment of 5% Trichoderma + Lime + Ash fungi in making straw compost significantly increased the levels of P nutrients in the compost. This is because lime and kitchen ash which are the result of burning wood contain a number of nutrients, especially nutrient P so that the addition of these two materials can increase nutrient levels in compost, especially nutrient Phosphorus (P).

Table 6. Average Value of Potassium content (%)

Treatment	Potassium	SNI quality standard (0,20)
JOL	0,32[a]	In accordance
JAL	0,39[bc]	In accordance
JKL	0,40[bc]	In accordance
JKAL	0,40[bc]	In accordance
JOD	0,33 [ab]	In accordance

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JAD	0,46^{c}	In accordance
JKD	0,40^{bc}	In accordance
JKAD	0,38^{ab}	In accordance

Note: Different superscripts in the same column show significantly different results at the 5% level according to the DMRT test

The content of Potassium (K) in the two composting treatments produced was included in the good category based on the SNI 19-7030-2004 organic fertilizer quality standards (< 25.50). The highest average value of Potassium (K) content in the treatment of composting in compost tanks was shown in the JCAL treatment, which was 0.40%, and the lowest was shown in the JOL control treatment, which was 0.32%. Almost the same thing also happened in the treatment of making compost in containers, the highest average value of Potassium (K) content was shown in the JAD treatment, which was 0.46% and the lowest was shown in the JOD control treatment, which was 0.33%. %. Based on the results obtained, compost made in both places, namely in containers and in compost tubs, can be used as fertilizer to increase plant nutrient levels, especially K nutrient levels because it is included in the good category according to SNI 19-7030-2004 organic fertilizer quality standards (0.20). Potassium element plays a role in the process of assimilation in plants. The mechanism of opening and closing of stomata is influenced by the presence of K ions, if the stomata are open it means that the physiological processes in plants will go well, especially the CO2 fixation process which will produce assimilate to meet the needs of plant life (Putro, Walidaini, Samudro, & Nugraha, 2016).

Based on the results of the variance showed that there were differences between treatments. The results of the DMRT follow-up test showed that composting in tubs in the JAL treatment, namely the combination of 5% Trichoderma + Lime + Ash fungi, had a significant difference from the control treatment (JOL), and not significantly different to the JAL and JKL treatments. Meanwhile, in composting in containers there was a significant difference between the JAD treatments, namely the combination of 5% Trichoderma + Ash fungi, and the JOD treatment (control), and there were no significant differences between the JAD, JKD and JKAD treatments. From the results of the variance it can be concluded that the combination of 5% Trichoderma fungi with other ingredients can increase the Potassium content in the Potassium compost in the soil, most of it cannot be absorbed directly by plants. Therefore, artificial fertilizers still need to be added to the soil (Purnomo, Sutrisno, & Sumiyati, 2017)

Discussion

The activity of Trichoderma sp which was added with ash and lime was able to increase the availability of nutrients N, P and K in making straw compost. However, the addition of ash and lime has not been able to meet SNI compost quality standards in terms of C/N ratio. The C/N ratio is the ratio between the amount of elemental carbon (C) to the amount of elemental nitrogen (N) present in an organic material. The C/N ratio is an indicator of a compost that can be applied as organic fertilizer. A good C/N ratio in compost is less than 0.20. If the C/N ratio is above this value, it indicates that the compost is not fully ripe, so when it is applied to organic fertilizer, it will result in Nitrogen (N) immobilization. Immobilization is the process of reducing N nutrients in the soil by microbial activity, so that the nutrient levels that can be used

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by plants is reduced. This research on making compost using Trichoderma sp activity still needs to be developed to find out the appropriate quantity comparison between Trichoderma sp and the addition of ash and lime, including how long it takes to get the best compost quality according to the Indonesian National Standard (SNI)

CONCLUSION

1. Provision of Trichoderma sp. activator. The composting process does not meet the SNI 19-7030-2004 organic fertilizer quality standards. However, the activity of Trichoderma sp with the addition of ash and lime was able to reduce the C/N ratio
2. There is no difference between the treatment in the container and the compost tub
3. The activity of Trichoderma sp compost can increase the nutrient content of N<P and K available in the compost so that the compost can be directly applied to soil and plants
4. The need for further research to determine the time needed to obtain the appropriate conditions of the C/N ratio in making straw compost using Trichoderma sp activity.
5.

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