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The Effect of Local Microorganism Based on Rice Waste and Composition of Planting Media on Growth and Yield of Pakchoy (*Brassica rapa* L.)

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ABSTRACT

Pakchoy is a leafy vegetable that is great demand by Indonesians. The increase in population has had a major impact on agricultural land, which has encouraged an urban farming system, using polybags for crop production. The use of soil media in polybags often experiences compaction and lack of nutrients, so it is necessary to modify the composition of the planting media and put additional fertilization. This research was conducted to evaluate the response of pakchoy to local microorganisms based on rice waste and to determine the best composition of growing medium for pakchoy plants. This study used a completely randomized design (CRD) with 2 factors. The first factor was the local microorganism (LMO) doses of rice waste consisted of 4 levels, namely 0 ml, 500 ml, 1000 ml, and 1500 ml per plant. The second factor was the composition of the planting medium (Soil : Sand: Cow Manure) at 4 levels, namely Soil 100%, 1:1:1, 1:1:2, 1:1:3. Data were statistically analyzed with ANOVA at 5% level. Mean separation was tested further with Duncan Multiple Range Test. The results showed that the LMO 0 ml and 500 ml performed higher effects on plant height, number of leaves, plant fresh and dry weight, root fresh and dry weight, and root length compared to the application LMO at 1000 ml and 1500 ml. The highest plant fresh weight was 193.1 g at 0 ml LMO, followed by 160.35 g at 500 ml LMO. The composition of the planting medium 1:1:1 and 1:1:2 resulted in a higher number of leaves, plant dry weight, and root weight than other treatments. Incorporating a high portion of manure into the pakchoy planting medium was not beneficial. All growth variables and yield were higher compared to the control medium (soil 100%).

INTRODUCTION

Pakchoy (*Brassica rapa* L.) is a horticultural commodity originating from China. Pakchoy is in great demand by the community and is a rain-resistant plant, regardless of the season, so it can be harvested throughout the year (Purba, 2017). Pakchoy may grow in both the lowlands and the highlands, but it grows well at altitudes of 900-1200 m above sea level (Ministry of Agriculture, 2009).

Indonesia's population growth rate continues to rise, from 171.35 million in 2020 to 272.23 million in 2021 (Dukcapil, 2021). This

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population growth rate significantly impacts food needs, agricultural land quality, and quantity, particularly in urban areas, driving urban farming activities. There are various techniques for carrying out urban agricultural activities. Still, the use of polybags is considered more effective because it is less expensive, more efficient, and easier to maintain (Safitri et al., 2020). Plants, on the other hand, frequently die due to compaction of the growing media, and the composition of the media used fails to meet the needs of the plants (Agoestin and Suhardjono, 2016). The appropriateness of the planting medium may promote optimal plant growth and development (Anjarwati et al., 2017). Because each media type has different contents and functions, the combination of planting media must have a proper composition for plants. Soil planting media can hold water, manure planting media can improve the soil's physical, chemical, and biological qualities, and sand planting media can improve aeration and drainage systems. In addition to these capabilities, planting media may enhance soil microbial activity and fertility (Putri et al., 2013).

Fertilizers, in addition to the composition of the planting media, may increase the availability of plant nutrients. Sufficient nutrient availability will produce optimal plant growth (Lestari et al., 2021). Rice waste liquid organic fertilizer can be used to increase the content of nutrients in the soil because the LMO in rice contain the fungus *Saccharomyces cerevisiae* and *Aspergillus niger* which function as starters to break down organic matter into nutrients available for plants (Maulana et al. ., 2021). Applying liquid organic fertilizer (LOF) produced from rice waste to the soil will improve soil structure and make the soil more friable, allowing the root system to develop better and nutrient absorption to function more efficiently (Saartje, 2013). The study aimed to evaluate the response of pakchoy to local microorganisms based on rice waste and to determine the best planting medium composition for the growth and yield of pakchoy.

MATERIALS AND METHOD

This research was conducted from December 2021 to February 2022 at Pasar Berkas, Teluk Segara District, Bengkulu City, Indonesia ± 10 above sea level. The materials used were pakchoy seeds of the Nauli F1 variety, planting media of soil, sand, cow mature, LMO based of rice waste, synthetic fertilizer (urea, KCl, and SP-36), water, and brown sugar. The study employed a Completely Randomized Design (CRD) with two factors. The first factor was LMO doses of rice waste at four different levels, namely 0 ml, 500 ml, 1000 ml, and 1500 ml per plant, according to that recommended by the Department of Agronomy Team. The second factor was the composition of the planting medium (soil: sand: cow manure) at four levels, namely soil 100%, 1:1:1, 1:1:2, and 1:1:3 Treatment combination was replicated three times. Each experimental unit consists of two polybags. There were 96 polybags of plants in all.

Local microorganisms (LMO) of rice waste preparation

LMO was prepared from rice waste, weighing 15 kg to produce 72 liters of LMO. Then the rice waste was fermented for two days. 1 kg of moldy rice waste was put into a plastic container, then 5 liters of water and 5 tablespoons of brown sugar was added. The waste rice, water, and brown sugar mixture were stirred until it was evenly mixed and ready to use (Putri, 2013). Local microorganisms were categorized as prepared to use after the mixture had a cloudy white color with a pH of 3.0 (acidic) due to the decomposition process of organic matter (Arifan et al., 2020).

Planting media preparation

The planting medium combines loamy soil, sandy soil, and cow manure. In this experiment, the loamy soil was considered as soil while sandy soil as sand. The results of the pH analysis showed soil pH = 6.40, sand pH = 6.88, and cow manure pH = 6.90. Loamy soil texture consists of sand = 65.41%; clay = 15.16

%, and silt = 19.43 %, while sandy soils have a texture of clay = 6.44 %, silt = 11.66 % and sand = 81.89 %. Loamy soil contains organic C = 1.84%; total N = 0.22 %, available P = 3.41 ppm and exchangeable-K = 0.09 me/100 g, sandy soil contains organic-C = 1.04%; total-N = 0.1 7%; available-P = 1.59 ppm; exchangeable-K = 0.01 me/100 g while manure contains C = 19.59%; N = 1.36 %; P = 0.89 ppm and K = 1.11 me/100 g.

The planting medium was dried for two days to suppress the development of bacteria, thereby minimizing the investation of pathogens and fungi. According to the treatment, the planting medium consisting of a mixture of soil, sand, and manure was put in a 30 cm x 30 cm polybag. Pakchoy seeds were sown in trays containing a mixture of manure, soil, and husk charcoal (1:1:1). Watering was done to keep the planting media moist. Seedlings were transplanted two weeks after sowing (WAS). Each polybag was planted with one pakchoi seed.

Application of Local Microorganisms Application and Fertilization

LMO from rice waste was applied to the plants two days after planting (DAP), 10, and 20 DAP at doses of 0 ml, 500 ml, 1000 ml, and 1500 ml, according to the treatment. Incorporating LMO around the roots was the method of application. Synthetic fertilizers were applied at rates of 0.4 g/plant for urea, 0.3 g/plant for SP-36, and 0.1 g/plant for KCl. Fertilizer was applied only once during the planting process. At 40 DAP, the leaves were harvested if greener and broader, and the leaf midribs were larger and thicker. The harvesting method involves uprooting the pakchoy leaves as well as the roots.

Observation variables and analysis data

Parameters observed included plant height (cm), number of leaves, leaves greenness, plant fresh weight (g), plant dry weight (g), root fresh weight (g), root dry weight (g), and root length (cm). The data were statistically analyzed using ANOVA at a 5% level. Mean separation was tested further with Duncan Multiple Range Test.

RESULTS AND DISCUSSION

Pakcoy Growth Pattern Due to LMO of Rice Waste

Pakchoy growth in the control treatment (0 ml) LMO, from the first week to the fourth week, tended to be higher compared to the other three treatments. Control plants had an average plant height of 14.01 cm, while at a dose of 500 ml, the plant height was 12.30 cm, at a dose of 1000 ml = 11.01 cm, and a dose of 1500 ml = 11.52 cm. The average leaf number growth in the first and second weeks at LMO doses of 0 ml and 500 ml was relatively similar and different from the 1000 ml and 1500 ml doses which showed lower leaf growth. The growth rate of the leaves number exhibited significant differences in the third and fourth weeks. LMO at a dose of 0 ml, the increase in the leaves number was higher = 7.91, followed by the other three treatments, namely 500 ml, 100 ml, and 1500 ml, respectively, with the leaves number namely 7.34, 6.52, and 6.62 (Fig.1 and Fig.2)

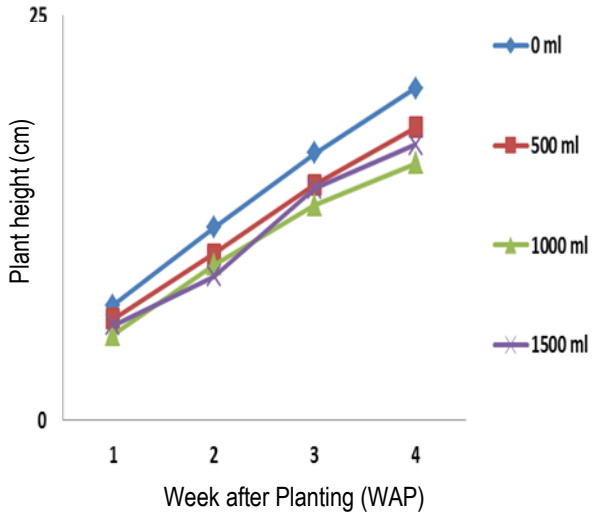

Figure 1. Plant height pattern of pakchoy at four doses of LMO rice waste

LMO in the range of 500 ml to 1500 ml had no significant effect on plant height and number of leaves. This insignificant effect showed that LMO rice waste could not be classified as a fertilizer to provide nutrients but as a liquid organic fertilizer that contained more microbes than nutrients. Microbes in the local microorganism solution have the

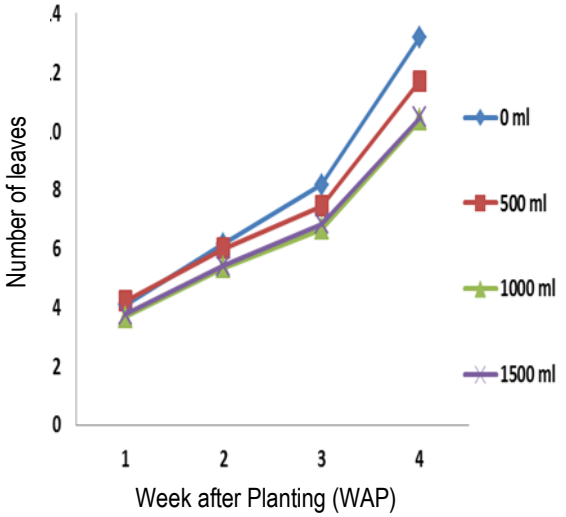

Figure 2. Leaves number pattern of pakchoy at four doses of LMO rice waste

potential to degrade organic waste materials into organic fertilizer. Microorganism solution is also known as one of the biological fertilizers.

Pakchoy Growth Pattern on Different Planting Media Compositions

Figures 3 and 4 indicate that varied growing media result in varying plant height and leaf number growth. The M2 treatment had the fastest growth pattern in plant height from the first to fourth weeks, followed by the M1, M3, and M0 treatments. The M0 treatment had the least growth pattern in plant height. The M2 treatment also showed the highest average leaves number= 7.55, followed by three other treatments, namely M3 = 7.45, M1 = 7.19, and M0 (soil 100%) = 6.18 (Fig. 3 and Fig 4).

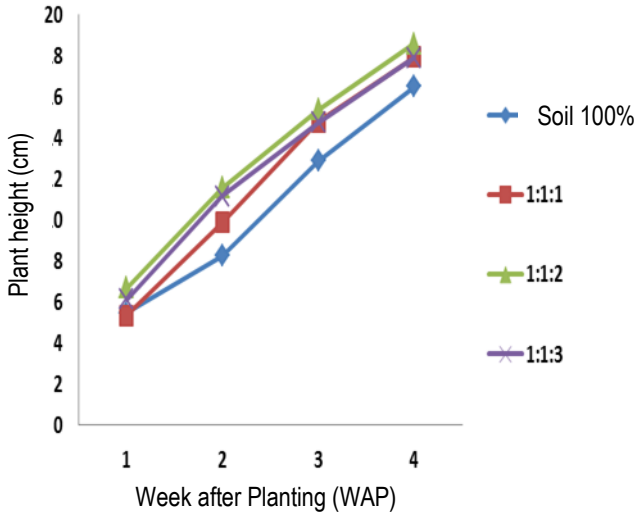

Figure 3. Plant height pattern of pakchoy at different media composition

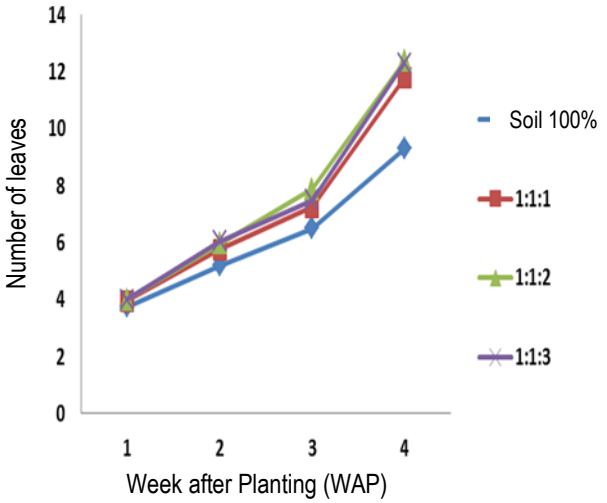

Figure 4. Leaves number pattern of pakchoy at different media composition

Variance Analysis of Pakchoy's Growth and Yield

The LMO of rice waste significantly affected plant growth (plant height, number of leaves, leaves greenness) and yields (plant fresh weight, plant dry weight, root fresh weight, root dry weight, and root length) (Table 1). The composition of the growing medium of soil, sand, and manure significantly affected plant growth (plant height, number of leaves) and yields (plant fresh weight, plant dry weight, root fresh weight). There was no interaction between the growth media composition and the LMO dose of rice waste.

This study's results align with Saptorini and Kustiani (2019) that there was no interaction between the composition of the media and the dosage of MOL liquid organic fertilizer for pakchoi. This result is apparently because the decomposition of organic material by bacteria in rice waste POC takes an extended time. According to Sultoni et al. (2019), three weeks showed an ineffective composting process with LMO rice waste compared to using EM4. Furthermore, the planting medium mixture of soil, sand, and manure has a high organic matter content, indicating that more micro and macro nutrients are available to support plant growth.

Effect of Microorganism Local Rice Waste Doses on Pakchoy

In the control treatment (LMO 0 ml), plant height, leaves number, and leaves greenness of

Table 1: Summary of the variance analysis of the effect of LMO rice waste and planting medium composition on the growth and yield of pakchoy

Variables	LMO	Media	LMO x Media	CV (%)
Plant height at 1st week	4.61*	2.36*	1.98 ns	20.05
Plant height at 2nd week	10.07*	11.31*	0.70 ns	13.76
Plant height at 3rd week	9.14*	7.85*	0.94 ns	10.55
Plant height at 4th week	25.10*	6.22*	1.24 ns	7.51
Leaves number at 1st week	6.25*	1.32 ns	0.75 ns	9.19
Leaves number at 2nd week	3.89*	3.41*	0.65 ns	12.68
Leaves number at 3rd week	8.11*	5.89*	1.15 ns	11.39
Leaves number at 4th week	8.46*	10.12*	0.56 ns	13.84
Leaves greenness	5.96*	1.10 ns	0.79 ns	4.96
Plant fresh weight	9.29*	6.88*	0.45 ns	16.25
Plant dry weight	9.08*	3.74*	0.55 ns	15.81
Root fresh weight	8.55*	3.94*	0.25 ns	18.46
Root dry weight	7.32*	0.93 ns	0.38 ns	17.4
Root length	3.94*	0.91 ns	0.66 ns	23.95

Note :* = significant different at the 5% levels ; ns= not significantly different

pakchoi were higher than the other treatments. LMO doses of 0 mL and 500 mL resulted in greater plant fresh and dry weight and root fresh and dry weight than doses of 1500 mL and 1000 mL. The root lengths produced by the treatment doses of 0 ml, 500 ml, and 1500 ml were not significantly different but were considerably different from the 1000 ml (Table 2). The 0 ml treatment showed the best results for the pakchoy observation variable. Julita (2013) explained in her research that the local microorganism treatment of rice waste did not significantly affect pakchoi plants. This is because LMO of rice waste is not classified as a fertilizer providing nutrients but as a liquid organic fertilizer containing more microbes than nutrients.

The control treatment (0 ml LMO) produced higher pakchoy than the higher doses. Julita (2013) also reported that the LMO of rice waste had no significant effect on pakchoi plants. LMO rice is not classified as a fertilizer providing nutrients but as a liquid organic fertilizer containing more microbes than nutrients. Ekawandani (2021), on the other hand, stated the LOF from rice waste did not produce nutrients following the standards of the Minister of Agriculture in 2011. The LMO of rice waste contained very low C-organic (0.00000194%) and did not meet the LOF standard—technical requirements for C-organic LOF of at least 6%. LOF rice waste is categorized as a type of soil enhancer (only able to improve soil properties).

Table 2. Effect of LMO of rice waste on the growth of pakchoy

LMO (ml)	Plant height (cm) 4th Week	Leaves number 4th Week	Leaves green-ness	Plant fresh weight (g)	Plant dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Root length (cm)
0	20.50 a	13.20 a	42.31 a	193.1a	9.21a	5.26a	0.68a	22.18a
500	18.09 b	11.70 b	39.93 b	160.35a	7.63a	4.21a	0.60ab	21.37a
1000	15.87 c	10.37 b	39.36 b	106.24b	5.47b	2.78b	0.38c	16.28b
1500	17.00 b	10.45 b	39.34 b	118.25b	5.45b	3.04b	0.46bc	18.61ab

Note: Numbers followed by the same letter in the same column are not significantly different at the 5% DMRT test

Increased LMO dose can inhibit pakchoy growth. Microbial metabolism results in high electron content when there are too many bacteria. According to Zahara (2011), the metabolic processes of Saccharomyces cerevisiae substrates produce electrons, whereas Haryanto (2015) states that the large amount of fertilizers induces very high electrical conductivity (EC) and increase the salt content. High salt concentrations inhibit plant root nutrients and water uptake. A high EC can limit the water potential in the soil, slowing plant growth and lowering plant yields.

Microbes utilize phosphorus and organic nitrogen to transform an element into a new structure in addition to degrading organic substances. Because of the enormous number of bacteria that utililze phosphorus and nitrogen as energy, there is competition for these elements between microbes and plants. According to Lens and Piet (2006), microbial development requires various elements as nutrition, both inorganic and organic. Nitrogen, phosphorus, carbon, oxygen, hydrogen, and sulfur are all required for microbial cell growth.

Nutrient deficiency prevents roots from providing nutrients for plant height, leaves number, leaves greenness and finally affects plant fresh and dry weight. Root fresh and dry weight, as well as root length, will suffer as a result of limited root distribution. Manullang (2014) states that roots interact directly with soil particles, particularly in absorbing N, P, and K.

Effect of Planting Media Composition on Pakchoy Growth and Yield

The M_2 treatment produced the tallest pakchoy plants, followed by the M_1 and M_3 treatments. Treatment M_0 (100% silt soil) produced shorter plants than treatments M_1, M_2, and M_3, M_0. The various planting media treatment resulted in more significant plant growth than the control treatment. Thus, the composition of the planting medium can better retain nutrients, making them available for the growth and development of pakchoi. The results of Jayanti's research (2020) indicate that adding sand and manure to the planting medium can enhance the physical properties of the medium so that it can store the nutrients. In contrast, cow manure contains nutrients that are available to plants.

Planting media serve an essential function in nutrient storage for plants. The soil structure of the growing media M1, M2, and M3 is remarkably crumbly. Plants, particularly vegetables, prefer the structure of crumbly soil because it contains pore spaces that can be filled with oxygen, groundwater, and nutrients, all of which are important for root development (Gustia, 2013). Using a mixture of sandy soil and manure as planting media can enhance the soil's ability to retain water, provide a favorable environment for germination and rooting, and serve as a plant nutrient source. Including sandy soil in planting media is intended to maintain the media's moisture content and capacity to retain water. In addition, the sand media's function is to keep the soil structure crumbly and loose to promote root growth and nutrient absorption. Using sand as a planting medium is essential because it creates a porous environment with beneficial aeration. When nutrients, the fundamental components of photosynthesis, become available, the rate of photosynthesis increases. The products of photosynthesis are utilized for plant growth and development, including root development. The increasing

Table 3. Effect of planting media composition on the growth and yield of pakchoy

Planting medium (soil: sand: manure)	Plant height (cm)	Leaves number	Plant fresh weight (g)	Plant dry weight (g)	Root fresh weight (g)
Silt soil 100%	16.49 b	9.29 b	96.76b	5.33b	2.71b
M_1 (1: 1: 1)	18.44 a	11.79 a	171.10a	7.89a	4.34a
M_2 (1: 1: 2)	18.63 a	12.38 a	169.49a	7.95a	4.42a
M_3 (1: 1: 3)	17.92 a	12.29 ab	140.63a	6.58ab	3.82ab

Note: numbers followed by the same letter at the same are not significantly different at the 5% DMRT test

number of plant roots will affect the fresh weight of the roots.

The decomposition of cow manure releases both macro and micronutrients in sufficient quantities for pakchoy growth. According to Ribeiro et al. (2017), the decomposition of organic matter releases plant-nutrients such as nitrogen, phosphorus, and potassium or increases nitrogen reserves in the soil to support plant height growth. The availability of water and compost in the soil substantially impacts the formation and development of plant organs. According to Manuhutu (2014), plant fresh weight (canopy) is a combination of the growth and development in plant tissue, such as plant height and leaf number, which are influenced by the plant tissue cells' water content and nutrient content. The greater the number of leaves, the greater the plant's fresh weight. The increased plant assimilation product in the formation of carbohydrates contributes to the increase in plant biomass.

The description of the variety shows that the average fresh weight of pakchoy is 408 g/plant. The yield of fresh plant weight in this study was lower, namely 275 g/plant or lower. The low yield of this plant is influenced by several factors that have been described, presumably also due to the influence of the growing medium's altitude, temperature, and pH. The altitude of the research site is 10 m above sea level, with an average temperature of the Bengkulu coastal area of 26° C, and the hottest (maximum) air temperature ever recorded was 36°- 37° C. (PMD Department, 2011). On the other hand, mustard greens grow well at an altitude of 900-1200 m above sea level, with temperatures at night of 15.6oC and during the day 21.1oC (Sastrahidayat and Soemrno, 1991). The pH of each growing medium also affects the growth and yield of pakchoy. Loamy soil has a pH of 6.40; sandy soil has a pH of 6.88; cow manure has a pH of 6.90. Rice waste LOF pH is 3.0, so plants grow under stress.

CONCLUSIONS

There was no interaction between liquid local microorganism (LMO) dosage of rice waste and planting media on pakchoi growth and yield. Treatment without LMO rice waste resulted in a higher average plant height, number of leaves, and leaves greenness compared to treatment with the addition of LMO. Control (0 ml) and 500 ml LMO concentrations produced a greater fresh and dry weight of plants, fresh and dry weight of roots, and root length than 1000 ml and 1500 ml LMO concentrations. Increasing the LMO dose of rice waste was not followed by an increase in the growth and yield of pakchoy. Planting media with a ratio of loamy soil: sandy soil: manure (1: 1: 1) and (1: 1: 2) produced the average plant height, number of leaves, plant fresh and dry weight, and fresh weight of pakchoy roots higher than that of the control treatment (100% soil) or 1:1:3 media composition.

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