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Effect of the combination of tofu liquid waste and plant media of sago waste on the growth of cayenne (*Capsicum frutescens* L.)

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1. Introduction

Sago (*Metroxylon* spp.) is one type of palm plant in the wet tropical. Sago plants have high adaptability to marginal land which does not allow optimal growth for food crops and plantation crops [1]. Sago is processed into various types of food, even in eastern Indonesia, sago is used as a staple food and processed into papeda.

This sago processing is also found in Jepara Regency, Central Java. Sago is used as a special food from this region, it is called as *horog-horog*. Sago which is only extracted resulting in solid sago waste. This sago waste is not widely used by the community, even though the organic matter content in sago waste is still high. Sago waste contains low crude protein around 2.30-3.36%, but the high starch content is 52.98% [2]. Sago waste is organic waste that is highly reactive to bioactivator compounds. Thus it is increasing the content of organic matter [3]. Therefore, sago waste has the potential to be used as organic fertilizer or planting media. In the research was done by Zaimah & Prihastanti [4], they used a mixture of sago waste compost with cow manure to increase the growth of strawberry plants. Compost sago waste is used to improve the quality of soil media so as to increase the growth of pakcoy (*Brassica rapa* var. *Chinensis*) [5]. However, the organic content and nutrients in sago waste do not meet the needs of plants.

Tofu is food that is often consumed by people every day. This processed food which made from soybeans produces liquid waste at the end of the process. Tofu liquid waste contains high organic matter. These organic compounds can be in the form of protein that is 40-60%, carbohydrates 25-50%,



oil, and fat 10% [6, 7], and have nutrients of N, P, K, Ca, Mg, and Fe [8], so liquid tofu waste has the potential to be used as liquid organic fertilizer. Research done by Hikmah [7] used liquid tofu waste for growth and yield of mung bean plants (*Vigna radiata* L.). Variations in fertilizer concentration from tofu liquid waste can have a significant effect on the growth of cayenne pepper [9]. Tofu liquid waste can also be applied with cow urine as a liquid organic fertilizer in the growth of cocoa seedlings [10]. Thus, this study also carried out a combination of liquid tofu waste in sago media because liquid tofu waste could not be applied singly even though the nutrient content was high and was used as a nutrient supplement in the sago planting media.

Cayenne pepper is a vegetable commodity that is needed every day for consumption. The demand for cayenne pepper must be directly proportional to its production, so the nursery is carried out by many farmers. Monthly production of cayenne pepper in Indonesia in 2012-2014 is very volatile but tends to increase [11]. The cultivation of cayenne pepper often uses plastic polybags for planting and when it must be moved, the polybag is torn and thrown away. Therefore, this sago waste planting media is expected to be used in planting cayenne pepper seeds and reducing the existing landfill. This study uses sago waste by adding liquid tofu waste. The purpose of this study is to determine the effect of tofu liquid waste concentration on fresh and black sago waste and which type of sago waste and the concentration of tofu waste that is the best for the growth of cayenne pepper seeds.

2. Materials and Methods

The materials used in this study were fresh and black solid sago waste from Plajan village, Jepara Regency, while the liquid tofu waste was from Poncoruso village, Semarang Regency, water, "Ready to Use" planting media, and superior seeds of a white cayenne plant of "Mahkota." The tools used in the study were ovens, digital scales, pots with a diameter of 10, ruler.

This study used factorial Completely Randomized Design (CRD) with three replications. There were two factors of research, namely planting media (M) and tofu waste concentration (T). The planting media factor consisted of 5 media, namely M0 (planting media), M1 (fresh sago), M2 (black sago), M3 (planting media + fresh sago), and M4 (planting media + black sago). While the waste tofu factor consists of 3 levels of concentration, namely 0%, 15%, and 30%, so there were 15 experimental units. Parameters in this study were: plant height, leaf number and area, root length, wet weight of roots and canopy, and dry weight of roots and canopy of plants. The data obtained were analyzed statistically with ANOVA (Analysis of Variance) test and DMRT (Duncan Multiple Range Test) advanced tests at a significant level of 5%.

The research was carried out in stages, starting from preparation, planting, giving treatment, maintenance, observation, and harvesting. Preparation included taking sago waste in Plajan village, Jepara Regency, tofu liquid waste extraction in Poncoruso Village, Semarang Regency, reducing sago waste mass by oven it at 69 degrees Celsius for 1 hour with 3 times weighing, seeding cayenne pepper seeds for planting, and media preparation plant in each pot 10 cm in diameter. Planting on the treatment media was carried out after the cayenne pepper seedlings were 30 days old, a homogeneous plant was selected and had 6-7 leaves to be used as a research test plant. After 2-3 days of adapting, the plants began to be treated with liquid tofu waste with the provision of tofu waste treatment carried out one time a week for five weeks. Plants were dosed twice a day (every morning and evening), and observations were conducted once a week. The plant parameters observed were plant height (measurements made using a ruler) and the number of leaves per plant. Harvesting was carried out at the end of the 5th week after being treated by in the form of corp extraction to the roots. The harvest parameters observed were root and canopy wet weight (weighed directly after harvest using digital scales) and the dry weight of roots and canopy, i.e., the weight of the plant after being dried using the oven at 60 degrees C for 24-48 hours. The length of the root was also measured using a ruler and the leaf area was measured using the ImageJ application on the computer after shooting on leaves arranged on white paper along with a ruler next to it to determine the known scale.

3. Results and Discussion

After five weeks of the experiment, the results of the research parameters are obtained that is there are significant differences in the average plant height, number of leaves, leaf area, and root length. These differences are shown by different notations. The average analysis results can be seen in Table 1.

Table 1. The results of the analysis of the average plant height, number of leaves, leaf area, and root length with the combination treatment of planting media and waste tofu concentration.

Treatment	Parameter			
	Plant Height (cm)	Number of Leaves	Leaves Area (cm ²)	Root Length (cm)
M0T0	19.57 ^a	5.00 ^{abc}	16.42 ^{ab}	8.00 ^{bcd}
M0T1	20.27 ^a	6.00 ^{abc}	15.04 ^{abc}	19.00 ^{ab}
M0T2	17.00 ^a	5.67 ^{abc}	16.09 ^{abc}	22.77 ^a
M1T0	18.90 ^a	4.00 ^c	14.33 ^{abc}	4.03 ^{de}
M1T1	0.00 ^c	0.00 ^d	0.00 ^d	0.00 ^e
M1T2	6.43 ^b	0.67 ^d	4.543 ^d	1.67 ^e
M2T0	19.70 ^a	5.67 ^{abc}	16.41 ^{ab}	14.77 ^{abcd}
M2T1	15.07 ^a	5.00 ^{abc}	12.33 ^{bc}	7.77 ^{bcd}
M2T2	18.23 ^a	5.00 ^{abc}	17.71 ^{ab}	15.40 ^{abcd}
M3T0	16.37 ^a	3.67 ^c	15.86 ^{abc}	7.73 ^{bcd}
M3T1	17.03 ^a	4.33 ^{bc}	13.84 ^{abc}	6.83 ^{cde}
M3T2	16.80 ^a	5.33 ^{abc}	13.18 ^{abc}	17.93 ^{abc}
M4T0	14.13 ^a	4.33 ^{bc}	10.40 ^c	24.83 ^a
M4T1	15.37 ^a	6.67 ^{ab}	14.13 ^{abc}	9.10 ^{bcd}
M4T2	20.50 ^a	7.33 ^a	18.69 ^a	9.37 ^{bcd}

Remarks: Numbers followed by the same superscript in the same column show an effect that is not significantly different between treatments based on Duncan's test 95% confidence level

M0: planting media T0 : 0%

M1: fresh sago T1: 15%

M2: black sago T2: 30%

M3: planting media + fresh sago

M4: planting media + black sago

3.1 Plant Height

The results in Figure 1 show that the treatment of M1T1 (fresh sago, 15% tofu waste) is significantly different from M1T2 (fresh sago, 30% tofu waste), but both are significantly different from other treatments. The average plant height is M4T2 (planting medium + black sago, 30% waste tofu).

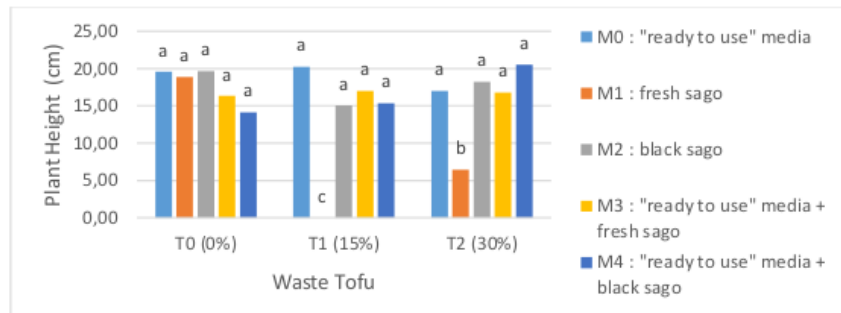


Figure 1. Average of Plant Height Histogram

The planting media used in this study has a high nutrient content with the composition of manure, husk, and humus soil, plus black sago which also has nutrient content as shown in (Table 2) which can increase plant height. Growing media is one of the important elements in supporting plant growth, because most of the nutrients needed by plants, supplied through growing media that are then absorbed by the roots and used for plant growth [12].

Table 2. Organic C content, total N, total P, and total K, and C / N ratio on black sago.

The Content of	Percentage (%)
Organic C	47.84
Total N	2.55
Total P	0.31
Total K	0.08
C/N ratio	18.76

3.2 Number of Leaves and Leaf Area

The highest average results for the parameters of leaf number and leaf area (Table 1) were found in M4T2 treatment (planting media + black sago with 30% tofu waste), which were 7.33 strands and 18.69 cm² respectively. Whereas, the lowest results are on fresh sago media treatment with 15% tofu waste (M1T1). This happens because the N element in the M1T1 media has been used by microbial decomposer for the process of fresh sago weathering, whereas in vegetative growth plants need the element of Nitrogen. Besides, the content of N in black sago is higher than fresh sago. Element N is the main nutrient for the growth of vegetative parts of plants, such as leaves, stems, and roots [12].

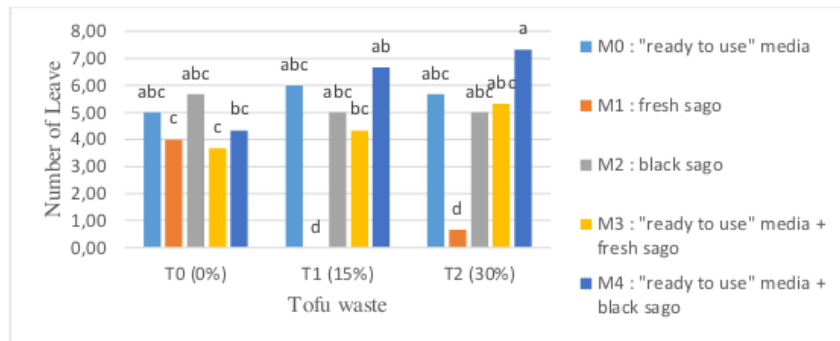


Figure 2. Average of Number of Leaves Histogram

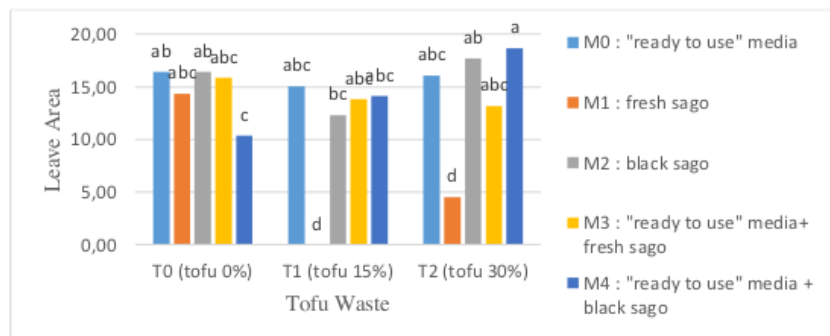


Figure 3. Average of Leaves Area Histogram

5 The histogram in (Figure 2) shows that in the treatment without tofu waste, black sago media has the highest number of leaves. In the treatment of tofu waste 15% and 30%, the highest number of leaves is in the treatment of black sago + planting media, but the highest is at a concentration of 30%.

Figure 3 shows that the largest leaf area is found in M4T2 treatment. Leaf area with black sago + planting media increased because it is added with 0% to 30% tofu waste. The lowest leaf area is found in M1T1 treatment and is not significantly different from M1T2. It is possible that when the fresh sago media is added with 15% tofu waste, there will be a growth bottleneck on the plant because the nutrients in the tofu waste which is little are used for microbial activity in the fresh sago decomposition process. Besides, fresh sago itself also has a high content of lignin and cellulose, so the elements slowly run out and the plants are in nutrient deficiency. Also, the N content in fresh sago is less than N in black sago.

3.3 Root Length

The highest average root length is in the treatment of planting media + black sago without giving out the waste of tofu. While the lowest root length is found in fresh sago media treatment with 15% concentration of waste (refer to Figure 4).

A good planting media is a media that provides enough nutrients and good aeration. Fresh sago has not decomposed so that the media is not able to bind water or nutrients perfectly. The combination or mixture of planting media has not been completely mixed and decomposed properly can be seen from the physical condition that has not been fused. If the planting media mixture provided is not composite, it can interfere with plant growth and even the roots of the plant can be wither and die [13].

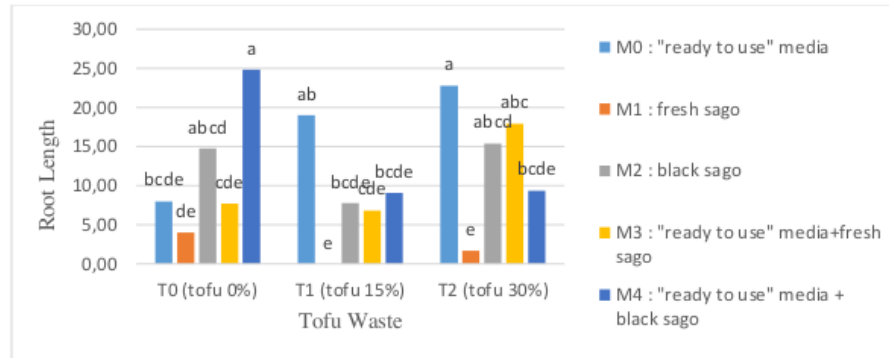


Figure 4. Average of Root Length Histogram

Table 3. Results of the analysis of the average wet weight of roots and canopy, as well as the dry weight of roots and canopy with the treatment combination of planting media and tofu liquid waste.

Treatment	Parameter			
	Dry Weight of Roots (gram)	Wet Weight of Canopy (gram)	Dry Weight of Roots (gram)	Dry Weight of Canopy (gram)
M0T0	2.54 ^{ab}	1.80 ^{cd}	0.23 ^a	0.37 ^{abc}
M0T1	2.86 ^a	2.31 ^{ab}	0.23 ^a	0.40 ^{ab}
M0T2	2.28 ^{abc}	1.65 ^{cd}	0.22 ^a	0.29 ^{cd}
M1T0	0.33 ^f	1.34 ^{ef}	0.08 ^c	0.26 ^{ef}
M1T1	0.00 ^f	0.00 ^g	0.00 ^d	0.00 ^g
M1T2	0.09 ^f	0.31 ^g	0.02 ^d	0.07 ^g
M2T0	1.96 ^{bcd}	2.11 ^{abc}	0.17 ^b	0.38 ^{abc}
M2T1	0.95 ^e	1.14 ^f	0.07 ^c	0.20 ^f
M2T2	1.38 ^{de}	2.04 ^{abcd}	0.14 ^b	0.36 ^{abcd}
M3T0	1.41 ^{de}	1.45 ^{ef}	0.14 ^b	0.27 ^{def}
M3T1	1.65 ^{cd}	1.54 ^{def}	0.15 ^b	0.30 ^{cd}
M3T2	1.76 ^{cd}	1.74 ^{cd}	0.17 ^b	0.31 ^{bcde}
M4T0	2.08 ^{bc}	1.49 ^{ef}	0.17 ^b	0.27 ^{def}
M4T1	2.06 ^{bc}	1.83 ^{bcde}	0.16 ^b	0.31 ^{bcde}
M4T2	2.80 ^a	2.34 ^a	0.22 ^a	0.42 ^a

Remarks: Numbers followed by the same superscript in the same column show an effect that is not significantly different between treatments based on Duncan's test 95% confidence level

M0: planting media

T0: 0%

M1: fresh sago

T1: 15%

M2: black sago

T2: 30%

M3: planting media + fresh sago

M4: planting media + black sago

3.4 Wet Weight of Root and Canopy

In Table 3, the highest average of root and canopy wet weight of plants, respectively, is 2.86 g and 2.34 g. The highest root wet weight is in planting media treatment with 15% tofu waste and when seen in Figure 5, is not significantly different from the treatment of planting media + black sago with the addition of 30% tofu waste. In (Figure 6), the highest of wet canopy weight is shown in M4T2 treatment (planting media + black sago, 30% waste tofu).

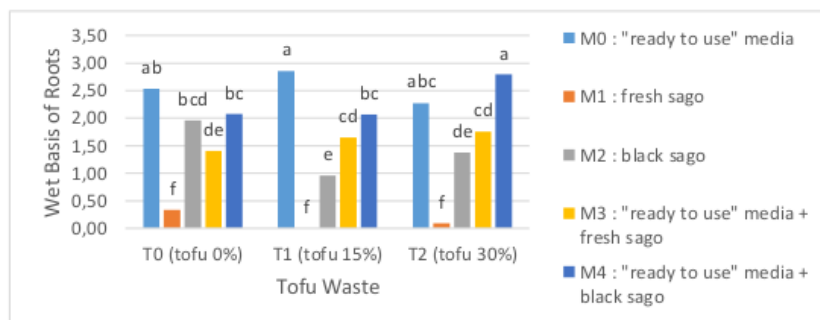


Figure 5. Average of Wet Weight of Roots Histogram

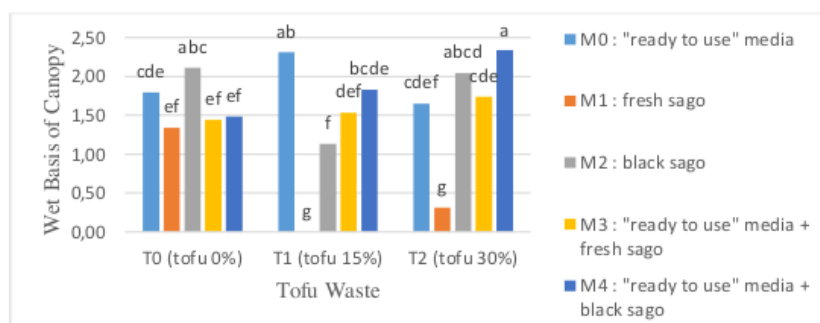


Figure 6. Average of Wet Weight of Canopy Histogram

This is possible because the planting media has sufficient N content for vegetative growth of plants. Nitrogen functions as a form of chlorophyll which plays an important role in photosynthesis [14]. Photosynthesis results are used for the growth of plant organs, the larger the plant organs are formed, the more moisture is bound to the plant [15], thus affecting the wet weight of the plant (roots and canopy).

The treatment of fresh sago media does not produce high wet weight because fresh sago media has low porosity. The lower the porosity of a planting medium, the denser the media is so that the structure of the growing media becomes less functional. Besides, compaction media makes root penetration more difficult [16].

Tofu liquid waste and the black sago planting media have given decomposed properly so that the roots easily absorb it, then the element is used for photosynthesis and photosynthesis results are distributed to all parts of the cayenne pepper plant. The plant's wet weight is influenced by the water content of the tissue, nutrients, and metabolic results [17].

3.5 Dry Weight of Roots and Canopy

The highest average of the dry weight of roots and canopy (seen in Table 3) is 0.23 g and 0.42 g respectively. In Figure 7, it can be seen that the treatment of planting media in each concentration of tofu waste has the highest root dry weight, and is not significantly different from the treatment of planting media + black sago with 30% tofu waste concentration. The treatment of black sago + planting media with 30% tofu waste concentration has the highest dry weight of canopy (Figure 8).

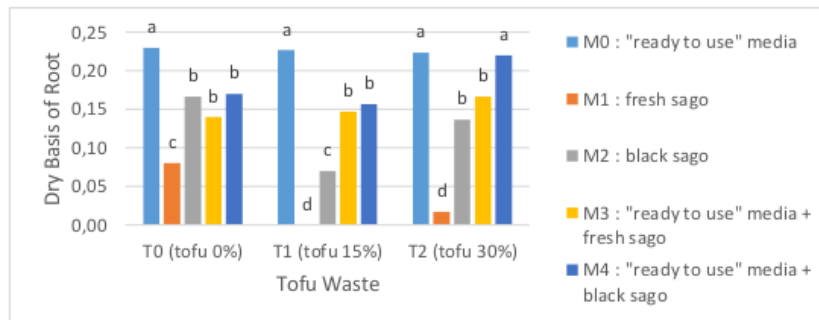


Figure 7. Average of Dry Weight of Root Histogram

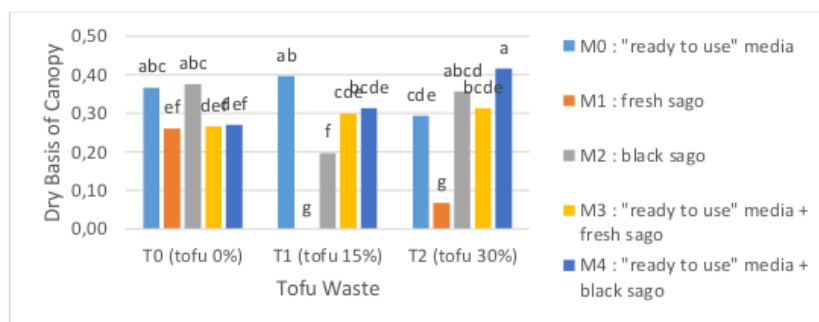


Figure 8. Average of Dry Weight of Canopy Histogram

The dry weight of root is an accumulation of organic compounds and is associated with root length growth, the longer the root will produce greater dry weight [18]. Plant dry weight is an indicator of plant growth, which is the result of the accumulation of plant assimilation obtained from the total growth and development of plants during life [19]. The greater the dry weight of the plant, it means the better the growth and development of the plant [20]. The rate of photosynthesis has an effect on the dry weight of plants where the higher the rate of photosynthesis increases the dry weight of plants [21].

4. Conclusion

Based on the research that has been done on cayenne pepper with the treatment of combination of sago waste and tofu liquid waste, it can be concluded that the combination treatment of liquid tofu waste with sago waste media affects the growth of cayenne pepper seeds in all parameters. Besides, the best combination treatment is the planting media and black sago with the addition of 30% concentration of tofu waste.

References

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