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# Using Sludge Palm Oil Mill Effluent (SPOME) as Results of Treatment with Natural Coagulants of Morage Seeds (Moringa oleifera) as Organic Fertilizer

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**Abstract**

The application of Sludge POME which has been treated with Moringa seed powder coagulant (Moringa oleifera) aims to determine its effect on soil fertility and its effect on the growth of chicory (Brassica rapa) as a test plant so that it is suitable as organic fertilizer. The parameters observed in this study consisted of 2, namely: a. The vegetative parameters of the test plants were plant height, number of leaves and fresh weight of biomass; b. Soil fertility parameters are: pH, N, P,-available, K - available, C - Organic. The experimental design used was a completely randomized design (CRD) with five treatments and five replications. The data collected from the research results are processed by the F test (at the level of accuracy of 5% and 1%), if the results of the F test indicate a significant difference as a result of the research treatment, it will be continued with the BNT test (smallest significant difference) at the 5% level. The experimental results show that: 1. The tendency of changes in the pH value in relation to the increase in the dose of addition of sludge indicates that, the higher the dose given, the higher the pH value of the soil. This happens before planting and after harvesting. This is presumably because in the sludge there are components of exchangeable bases such as K, Na, Ca and Mg which can neutralize the solubility of H+ ions; 2.

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Type of change in Organic C value increases in line with the increase in sludge dosage. This is because the main source of Organic C is the organic matter present in the sludge; 3. The pattern of increasing the total N content in the soil before and after planting was closely related to the dose of addition of sludge to the soil. However, qualitatively, increasing the dose of sludge from 200 g to 800 g did not change the status of the presence of Total N in the soil. All are in Medium status; 4. The availability of P in the soil, after harvesting, showed that treatments P1, P2, P3 and P4 showed an increasing effect on the available P content in the soil. For P4 treatment (a dose of 800 g) caused a change in the availability of soil P status from Medium to High. This condition was caused by the mineralization process of total P in the sludge and the presence of organic acids that helped release P in soil colloids; 5. Total K content, the effect of sludge application causes an increase in the available K content in the soil after harvesting. This is because there is a supply of K available from the decomposition process of the organic matter content in the sludge; 6. The effect of increasing the dose of sludge is positively correlated with the increase in height of mustard plants after harvest. This is illustrated by the results of a very strong correlation test with a value of r = 0.96; 7. The increase in sludge dose on the increase in mustard leaves after harvest showed a very strong relationship. This can be seen from the value of r = 0.92. This condition was presumably because the sludge contained sufficient N to support the growth of mustard leaves; 8. There is a very strong relationship between the increase in the wet weight of mustard leaves and the increase in sludge dose, the relationship tends to increase from treatment P0 to P4. Based on the results of the correlation test, it shows a very strong relationship with the value of r = 0.96.

***Keyword:*** Sludge Palm Oil Mill Effluent (SPOME); Moringa seed powder coagulant (Moringa oleifera); Organic Fertilizer.

## 1. Introduction

Palm oil processing plants produce three types of waste, namely solid, liquid and gas waste. Palm oil mill effluent (LCPKS) is the most waste produced from fresh fruit bunches of oil palm. In one fresh fruit bunch of oil palm about 60% is LCPKS. LCPKS is better known as POME (Palm Oil Mill Effluent) [3]. POME is one of the main wastes of the palm oil industry which has the most problematic potential for environmental pollution among other factory wastes [7]. POME effluent from palm oil mills can contaminate rivers and surrounding soil because it has a low pH, high oil and fat content and other contaminants [6]. According to [5] Nutrients owned by POME are needed by plants, POME is rich in organic compounds and carbon dioxide. POME contains large amounts of nitrogen, phosphate, calcium, magnesium and potassium so it can be used as fertilizer. Sludge POME is produced from the precipitation and filtration process using a coagulant. The use of natural coagulants as a solution to reduce environmental pollution due to the use of chemical coagulants. One type of natural coagulant is Moringa seed powder (Moringa oleifera). Moringa seeds contain the bioactive compound rhamnosyloxy – benzyl – isothiocyanate, which is able to adopt and neutralize the sludge and metal particles contained in the suspension waste with dirt particles floating in the water, so it is very potential to be used as a natural coagulant to clean water so that it is drinkable. According to [17], the advantage of Moringa seeds as a coagulant compared to commonly used chemical coagulants such as alum is its ability to precipitate various dissolved metal ions and harmful bacteria besides being easy to obtain in the surrounding environment. Sludge POME treatment with Moringa seed powder at a dose of 4 g/liter showed the highest N-Total value (1.70%); the

highest P-Total content (0.44%); the highest total K-content (0.61%) [8]. The trial application of Sludge POME that has been treated with Moringa oleifera powder coagulant aims to determine its effect on soil fertility and its effect on the growth of chicory (Brassica rapa) so that it is suitable as organic fertilizer.

## 2. Research Methods

The materials used are Sludge POME preparations that have been treated with Moringa (Moringa oleifera) seed powder at a dose of 4 g/liter, Cauliflower (Brassica rapa) seeds that have been sown, Soil as a growing medium, Polybags (18 x 30 cm) as planting media container. The experimental design used was a completely randomized design (CRD) with five treatments and five replications as follows:

**Table 1:** Treatment Dose of Selected Sludge and Repeat.

| Selected Sludge Treatment Dose (g) | Repetition | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 0.0 | 0 | 0 | 0 | 0 | 0 |
| 200 | 200 | 200 | 200 | 200 | 200 |
| 400 | 400 | 400 | 400 | 400 | 400 |
| 600 | 600 | 600 | 600 | 600 | 600 |
| 800 | 800 | 800 | 800 | 800 | 800 |

### *2.1 Experiment Execution*

Preparation of fertilizer, the first step is to weigh the Sludge which will be used as fertilizer for the test plants, with doses of 0 g, 200 g, 400 g, 600 g and 800 g. ; b. Filling Polybags with soil, Polybags filled with soil that has been loosened as much as 5 kg as a growth medium; c Stages of giving Sludge, giving Sludge to each Polybag that has been filled with soil in accordance with the label that has been given; d. Planting Test Plants, planting test plants in each polybag, after 7 days Sludge is given. This is to avoid the influence of organic acids that can kill the roots of the test plants because they are still in a vulnerable state.

### *2.2 Observation Parameters*

The parameters observed in this study consisted of 2, namely: a. The vegetative parameters of the test plants were plant height, number of leaves and fresh weight of biomass; b. Soil fertility parameters are: pH, N, P,-available K-available, C-Organic.

### *2.3 Data Analysis Method*

The data analysis method used in this study is presented in the following table :

**Table 2:** Soil fertility analysis method.

| No | Parameter | Unit | Analysis/Measurement Methods | Sample Source |
|---|---|---|---|---|
| 1. | pH | - | Dissolved with $H_2O$ and KCl in a ratio 1 : 2.5 | Sludge |
| 2 | C – organic | (%) | Welkey dan black | Sludge |
| 3 | N – total | (%) | Kjeldahl | Sludge |
| 4 | P-Available dan K-Available | ppm | Extraction Bray 1 | Sludge |

The data collected from the results of this study will be tested by statistical methods, namely the F test (at the level of accuracy of 5% and 1%). Furthermore, if the results of the F test indicate a significant difference as a result of the research treatment, it will be continued with the BNT test (smallest significant difference) at the 5% level. The pattern of variance in this study can be seen in the following table :

**Table 3:** Analysis of Variance (ANOVA) for Data Analysis Results.

| Source of Divesity | Free Degrees (db) | Sum of Squares | Middle Square | $F_{Count}$ | $F_{Table}$ |
|---|---|---|---|---|---|
| Treatment | t - 1 | JKP | KTP | KTP/KTG | |
| Error | t(r-1) | JKG | KTG | | |
| Total | tr - 1 | JKT | | | |

## 3. Results and Discussion

### Soil pH

The results of testing the soil pH before and after planting white mustard (**Brassica rapa**) after being given the Sludge POME treatment are shown in the following table and graph:

**Table 4:** Effect of Different Doses of Sludge POME on Soil pH Before Planting and After Harvest.

| No. | Treatment | Before Planting | | After Planting | | Different Value |
|---|---|---|---|---|---|---|
| | | Value | Status | Value | Status | |
| 1 | Dose 0 g (P0) | 4.79 | M | 4.87 | M | 0.08 |
| 2 | Dose 200 g (P1) | 5.24 | M | 5.11 | M | -0.13 |
| 3 | Dose 400 g (P2) | 5.45 | M | 5.32 | M | -0.13 |
| 4 | Dose 600 g (P3) | 5.89 | AM | 5.69 | AM | -0.20 |
| 5 | Dose 800 g (P4) | 6.21 | AM | 6.02 | AM | -0.19 |

Note: M= Sour AM= A bit sour

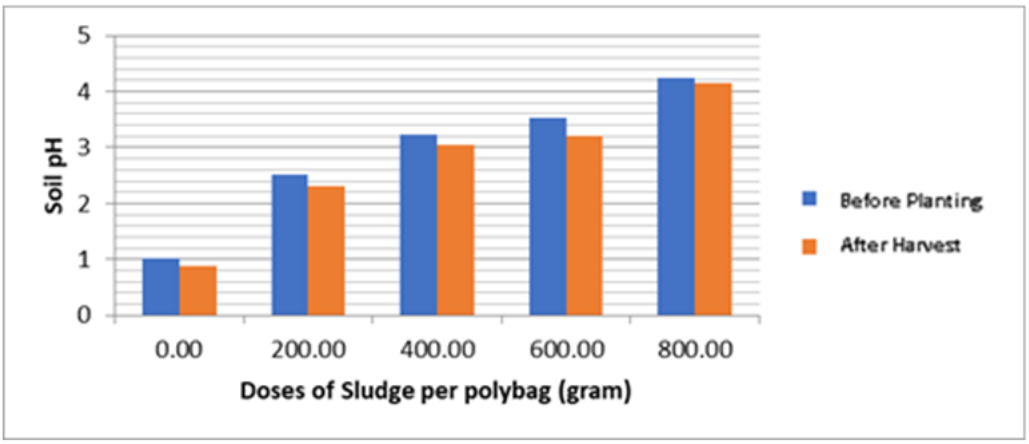


**Figure 1:** The Relationship Between Increasing Sludge POME Dose To Changes in Soil pH Value Before Planting and After Harvest.

From Table 4. above, it can be seen that the lowest value of soil pH before planting was found in the P0 treatment (0.00 g dose) with a value of 4.79 (Sour). While the highest pH value was found in treatment P4 (Dose 800 g) with a pH value of 6.21. Based on these data, it shows that the administration of Sludge POME has the effect of increasing soil pH. The same pattern was also found in soil pH after harvesting mustard greens. The highest pH value of the soil after harvesting was found in the P0 treatment (0.00 g dose) with a value of 4.87 (Sour). While the highest pH value was found in treatment P4 (Dose 800 g) with a pH value of 6.02. The same thing was also stated by [14] which stated that the use of oil palm sludge was able to increase the soil pH of ultisols from a pH value of 4.90 to 5.33 in the corn (Zea mays) cultivation process, with a fertilizer dose of 127.5 g/15 kg. Based on Figure 1 above, it can be seen that the tendency of changes in the pH value in relation to the increase in the dose of addition of sludge indicates that the higher the dose given, the higher the pH value of the soil. This happens before planting and after harvesting. This is presumably because in the sludge there are components of exchangeable bases such as K, Na, Ca and Mg which can neutralize the solubility of H+ ions. Based on Table 4 above, it can be seen that the difference in pH values before planting and after harvesting showed the highest number was found in the P4 treatment (800 g dose) with a difference of -0.19. This indicates that the decomposition process of sludge also produces organic acids. These organic acids cause a decrease in the pH. This was also reported by [13] who stated that in the composting process, acid-forming bacteria will lower the pH so that the compost is more acidic.

**C-organik**

The results of the research on changes in soil organic C after adding sludge, can be seen visually in the following table and graph:

**Table 5:** Effect of Different Doses of Sludge POME on Organic C (%) Soil Before Planting and After Harvest.

| No. | Treatment | Before Planting | | After Planting | | Different Value |
|---|---|---|---|---|---|---|
| | | Value | Status | Value | Status | |
| 1 | Dose 0 g (P0) | 1.02 | R | 0.89 | SR | -0.13 |
| 2 | Dose 200 g (P1) | 2.52 | S | 2.31 | S | -0.21 |
| 3 | Dose 400 g (P2) | 3.24 | T | 3.04 | T | -0.20 |
| 4 | Dose 600 g (P3) | 3.53 | T | 3.21 | T | -0.32 |
| 5 | Dose 800 g (P4) | 4.25 | T | 4.15 | T | -0.10 |

Note : R= Low SD= Middle T= High

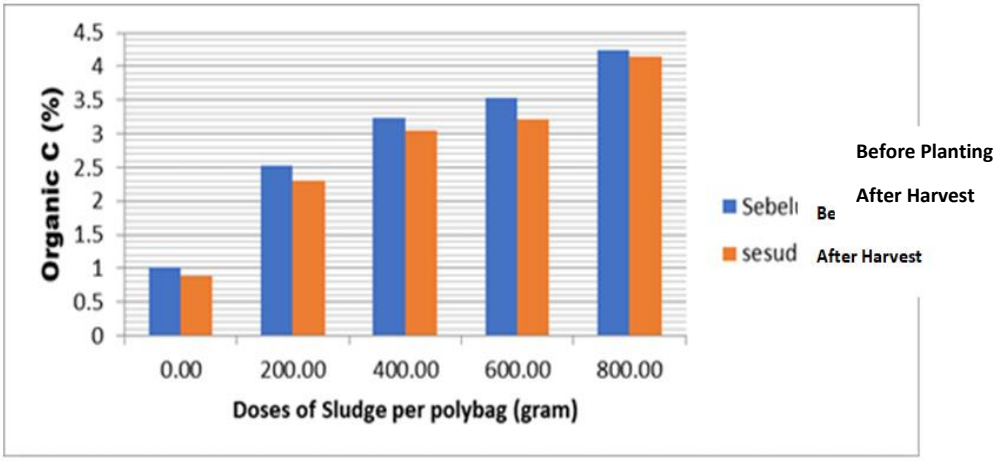


**Figure 2:** The Relationship Between Increase in Sludge POME Dose and Changes in Organic C (%) of Soil Before Planting and After Harvest.

From Table 5 above, it can be seen that the lowest value of soil organic C before planting was found in the P0 treatment (dose 0 g) with a value of 1.02% (Low). Meanwhile, the highest Organic C value was found in treatment P4 (Dose 800 g) with an Organic C value of 4.25% (High). The same pattern was also found in the Organic C content after harvest. The lowest Organic C value was found in treatment P0 (Dose 0 g) with a value of 0.89% (Very Low) and the highest in treatment P4 (Dose 800 g) with an Organic C value of 4.15% (High). Based on Figure 2, it can be seen that the type of change in the Organic C value increases with the increase in the sludge dose. This happens because the main source of Organic C is the organic matter present in the sludge. This is in line with the opinion of [15], which stated that POME mud has great potential if it is used for organic fertilizer (as slow release fertilizer pellets. Slurry) because the organic matter content is very high. Based on Figure 2 above, it can be seen that in general there was a decrease in the C-Organic content in the soil after harvesting mustard greens (at treatments P1, P2, P3 and P4). But the decrease did not change the status of the availability of organic C in the soil. This decrease is predictable because some of the C-Organic is decomposed and partly evaporates into the air in the form of $CO_2$ gas. This is in line with [12], this process involves the

activity of micro-organisms. Carbon enters the atmospheric environment from the biosphere as carbon dioxide gas resulting from decay / fermentation by bacteria / fungi.

**Nitrogen**

The results of the analysis of N-total soil after being given Sludge POME before planting and after harvesting mustard greens are visually displayed in the table and graph below:

**Table 6:** Effect of Different Doses of Sludge POME on Total N Content (%) of Soil Before Planting and After Harvest.

| No. | Treatment | Before Planting | | After Planting | | Different Value |
|---|---|---|---|---|---|---|
| | | Value | Status | Value | Status | |
| 1 | Dose 0 g (P0) | 0.12 | R | 0.11 | R | -0.01 |
| 2 | Dose 200 g (P1) | 0.23 | SD | 0.27 | SD | 0.04 |
| 3 | Dose 400 g (P2) | 0.26 | SD | 0.32 | SD | 0.06 |
| 4 | Dose 600 g (P3) | 0.35 | SD | 0.39 | SD | 0.04 |
| 5 | Dose 800 g (P4) | 0.45 | SD | 0.52 | SD | 0.07 |

Note : R= Low SD= Middle

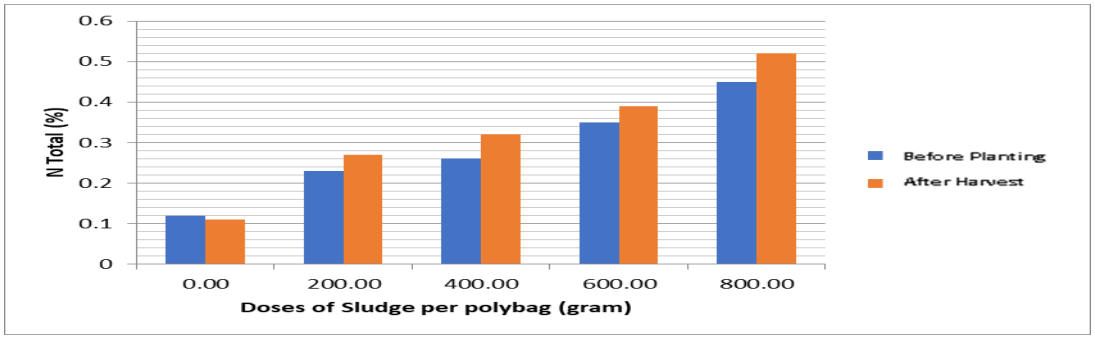


**Figure 3:** The Relationship Between Increase in Sludge POME Dose and Changes in Total Soil CN Before Planting and After Harvest.

From Table 6, it can be seen that the smallest value of N total soil before planting was in the P0 treatment (dose 0 g) with a value of 0.12% (Low). This also happened after harvesting, the lowest total N value was found in treatment P0 (dose 0 g) with a value of 0.11% (Low). The highest total N value before planting was found in treatment P4 (Dose 800 g) with a value of 0.45% (Medium). Likewise, after harvesting, the highest total N value was found in treatment P4 (Dose 800 g) with a value of 0.52% (Medium). Based on Figure 3 shows that the pattern of increasing the total N content in the soil before and after planting is closely related to the dose of adding sludge to the soil. However, qualitatively, increasing the dose of sludge from 200 g to 800 g did not change the status of the presence of Total N in the soil. All are in Medium status. The same thing was also stated by [14] which states that the use of oil palm sludge does not increase the total N of soil ultisols. From Table 6 above, it can be seen that in general there was an increase in the total N content in the soil after harvesting mustard greens (in treatments P1, P2, P3 and P4). This is presumably because the sludge fertilizer undergoes a

decomposition process from application before planting to harvesting. This decomposition process produces element N which then becomes a form that can be absorbed by plants. Reported by I.G. P. A. Suryawan and his colleagues 2016 that in the composting process (decomposers of organic matter) nitrogen (N) levels can increase up to 2.71%.

**P-Available**

The results of the analysis of the effect of the Sludge POME dose on the available P content in the soil are visually shown in the following table and graph:

**Table 7:** The Effect of Different Doses of Sludge POME on the Available P Content (ppm) of Soil Before Planting and After Harvest.

| No. | Treatment | Before Planting | | After Planting | | Different Value |
|---|---|---|---|---|---|---|
| | | Value | Status | Value | Status | |
| 1 | Dose 0 g (P0) | 12.21 | R | 10.24 | R | -1.97 |
| 2 | Dose 200 g (P1) | 14.35 | R | 19.23 | R | 4.88 |
| 3 | Dose 400 g (P2) | 12.37 | R | 16.32 | R | 3.95 |
| 4 | Dose 600 g (P3) | 14.34 | R | 21.22 | SD | 6.88 |
| 5 | Dose 800 g (P4) | 19.21 | SD | 26.21 | T | 6.00 |

Note : R= Low SD= Middle T = High

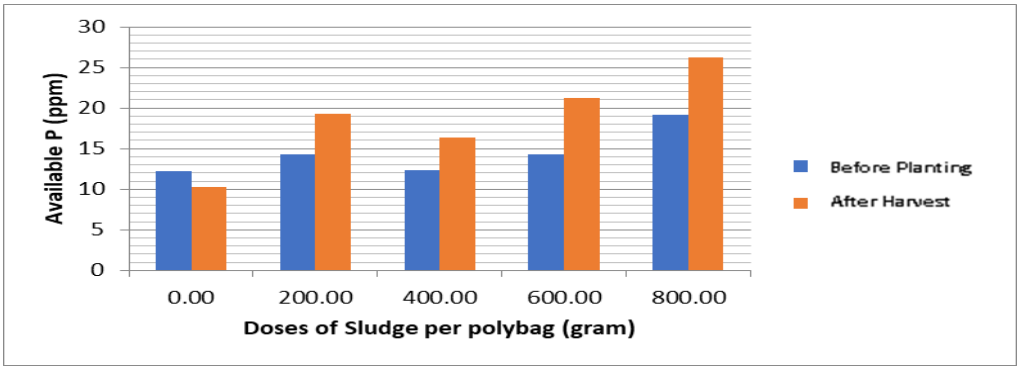


**Figure 4:** The Relationship Between Increase in Sludge POME Dose and Changes in Available P (ppm) of Soil Before Planting and After Harvest.

Based on Table 7 above, it can be seen that the effect of sludge treatment on the P value of available soil (before planting mustard greens) showed the highest concentration was found in P4 treatment (dose of 800 g) with a value of 19.21 ppm (Medium). While the lowest value was found in the P0 treatment (dose of 0 g) with a value of 12.21 ppm (Low). The same pattern also occurs after harvesting mustard greens. The available P content in the soil showed the lowest number was found in the P0 treatment (dose of 0 g) with a value of 10.24 ppm (Low). On the other hand, the highest number was found in treatment P4 (dose of 800 g). with a value of 26.21 ppm (High). Quantitatively, the application of sludge to the soil can increase the available P content from the smallest to the highest dose. On the other hand, qualitatively the provision of the sludge caused a change in the available P status in the soil only in the P4 treatment, with a medium availability status. This condition is

presumably because at the initial stage of giving the sludge (before planting), the total P content of the sludge has not been decomposed into a form available to plants. In other words, the P content of the sludge is still in the form of organic compounds. Based on Figure 4, it can be seen that after harvesting, it was shown that the P1, P2, P3 and P4 treatments showed an effect that increased the available P content in the soil. For P4 treatment (a dose of 800 g) caused a change in the availability of soil P status from Medium to High. This condition was caused by the mineralization process of total P in the sludge and the presence of organic acids that helped release P in soil colloids. This is in accordance with the opinion of [16], The addition of organic matter can increase the availability of P in the soil. The effect of organic matter on the availability of P can be directly through the mineralization process or indirectly by assisting the release of fixed P. The results of the decomposition of organic matter in the form of organic acids can form bonds with Al and Fe ions so that it can reduce the solubility of Al and Fe ions, thereby increasing the availability of P.

**K-Available**

The results of the analysis of the effect of the Sludge POME dose on the K content available in the soil before planting mustard greens and after harvesting are shown in tables and graphs as follows:

**Table 8:** Effect of Different Doses of Sludge POME on Available K Content (mg/100 g) Soil Before Planting and After Harvest.

| No. | Treatment | Before Planting | | After Planting | | Different Value |
|---|---|---|---|---|---|---|
| | | Value | Status | Value | Status | |
| 1 | Dose 0 g (P0) | 11.22 | R | 10.63 | R | -0.59 |
| 2 | Dose 200 g (P1) | 12.02 | R | 12.92 | R | 0.90 |
| 3 | Dose 400 g (P2) | 13.21 | R | 16.52 | R | 3.31 |
| 4 | Dose 600 g (P3) | 14.22 | R | 20.42 | SD | 6.20 |
| 5 | Dose 800 g (P4) | 15.12 | R | 22.22 | SD | 7.10 |

Note : R= Low SD= middle T = High

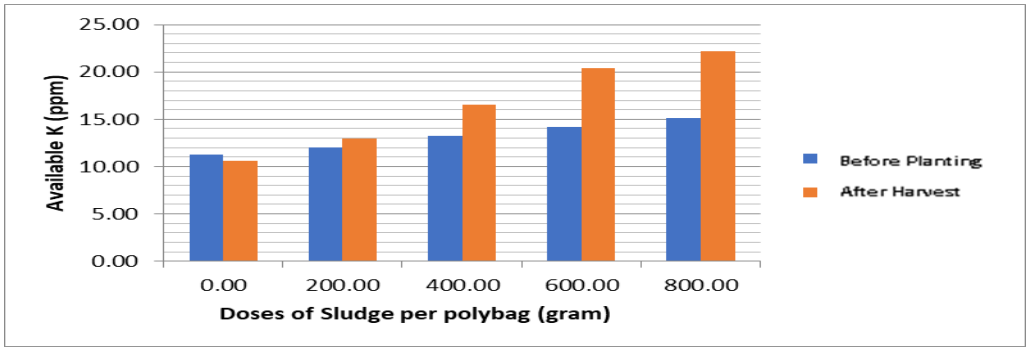


**Figure 5:** Relationship Between Increase in Sludge POME Dose and Change in Available K (mg/g) Soil Before Planting and After Harvest.

From Table 8, it can be seen that the effect of sludge treatment on the value of available K in the soil before planting, showed that the highest value was found in P4 treatment (with a dose of 800 g of sludge) with a value

of 15.21 mg/100 g (Low). While the lowest value was found in the P0 treatment (without sludge) with an available K value of 11.22mg/100 g (Low). While the K value of available soil after harvesting showed a similar pattern, the highest was in treatment P4 with a value of 22.22 mg/100 g (Medium) and the lowest was in treatment P0 with a value of 10.63 mg/100 g (Low). Quantitatively, the application of sludge to the soil can increase the available K content from treatments P1 to P4. On the other hand, qualitatively the provision of the sludge caused a change in the available K status in the P3 and P4 treatments. The status changes from Low to Medium. Based on Figure 5, it can be seen that quantitatively the effect of sludge application causes an increase in the available K content in the soil after harvesting. This is because the supply of K is available from the decomposition process of the organic matter content in the sludge. Different things were reported by [14] which states that the use of palm oil sludge does not increase the available K in ultisol soils. This difference is presumably due to the use of different doses in the two studies. In this study, a higher dose of sludge was used.

**Mustard Plant Parameters**

**White Mustard Plant Height (Brassica rapa)**

The results of measurements of the height of the mustard plant after being given the addition of sludge on the soil for the growth media are shown in the following table and graph:

**Table 9:** The Effect of Different Doses of Sludge on Planting Media Soil on Height (cm) of White Mustard (Brassica rapa) at Harvest.

| No. | Treatment | Repetition (cm) | | | Total | Average |
|---|---|---|---|---|---|---|
| | | R1 | R2 | R3 | | |
| 1. | Dose 0 g (P0) | 17.21 | 20.19 | 19.16 | 56.56 | 18.85[a] |
| 2. | Dose 200 g (P1) | 22.43 | 22.25 | 22.14 | 66.82 | 22.27[b] |
| 3. | Dose 400 g (P2) | 18.24 | 23.42 | 25.21 | 66.87 | 22.29[b] |
| 4. | Dose 600 g (P3) | 27.67 | 25.21 | 26.21 | 79.09 | 26.36[c] |
| 5. | Dose 800 g (P4) | 29.32 | 28.18 | 27.21 | 84.71 | 28.24[c] |

Note: Numbers followed by the same letter in the same column are not significantly different in the BNT5% test

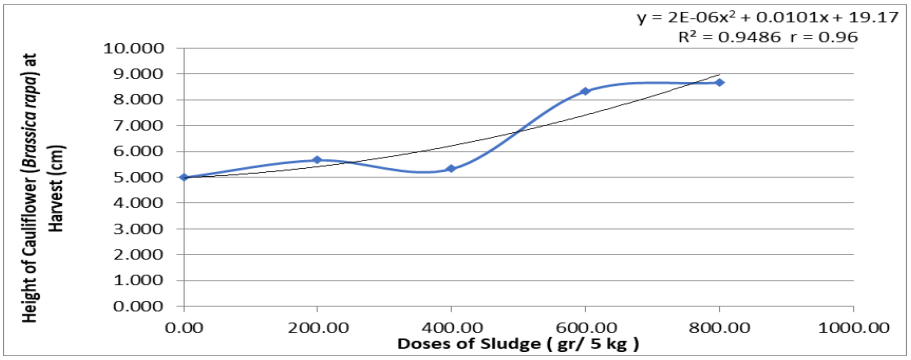


**Figure 6:** The Relationship Between Increase in Sludge Dose and Height of Cauliflower (Brassica rapa) at Harvest.

From Table 9 above, it can be seen that the lowest value of mustard plant height after harvest was found in the P0 treatment (0.00 g/5 kg Sludge dose) with a value of 18.85 cm. This treatment was significantly different from all other treatments. While the highest mustard height was found in treatment P4 (Sludge dose 800 g/5 kg) with a height of 28.24 cm, the treatment was not significantly different from treatment P3 (Sludge dose 800 g/5 kg). This indicates that the effective dose of Sludge on the growth of mustard plant height is at P3 (Sludge dose 600 g/5 kg). Although this treatment did not show the highest value for mustard height, it was not significantly different from the P4 treatment. Based on Figure 6, it can be seen that the effect of increasing the dose of sludge is positively correlated with the increase in the height of the mustard plant after harvest. This is illustrated by the results of a very strong correlation test with a value of r = 0.96. Different things were stated by [11] which states that the provision of solid waste from palm oil mills does not have a significant effect on the increase in plant height of soybeans (Glecine Max L.). The difference in the results of these two studies should be suspected because the dose used in the soybean plant study was too low. This causes the availability of nutrients in the sludge is also low, so it does not have a significant effect on the growth of soybean plants (Glecine Max L.)

**The Number of Leaves White Mustard Plant (Brassica rapa)**

The results of measurements of the number of mustard leaves after being given sludge treatment with different doses on the soil are shown in the following table and graph:

**Table 10:** The Effect of Giving Different Doses of Sludge on Soil Planting Media on the Number of Leaves (fruit) of Cauliflower (Brassica rapa) at Harvest.

| No. | Treatment | Repetition (cm) | | | Total | Average |
|---|---|---|---|---|---|---|
| | | R1 | R2 | R3 | | |
| 1. | Dose 0 g (P0) | 5 | 5 | 5 | 15.00 | 5.00[a] |
| 2. | Dose 200 g (P1) | 6 | 5 | 6 | 17.00 | 5.67[a] |
| 3. | Dose 400 g (P2) | 6 | 5 | 5 | 16.00 | 5.33[a] |
| 4. | Dose 600 g (P3) | 8 | 8 | 9 | 25.00 | 8.33[b] |
| 5. | Dose 800 g (P4) | 9 | 9 | 8 | 26.00 | 8.67[b] |

Note: Numbers followed by the same letter in the same column are not significantly different in the BNT5% test

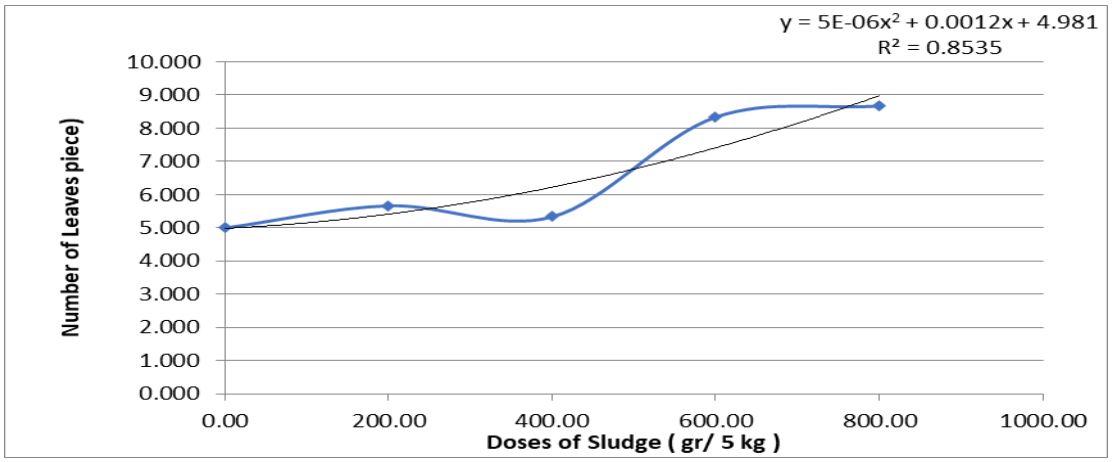


**Figure 7:** Relationship Between Increase in Sludge Dose and Number of Leaves of White Mustard (Brassica rapa) at Harvest.

From Table 10 above, it can be seen that the lowest value of the number of green mustard leaves after harvest was found in the P0 treatment (0.00 g/5 kg Sludge dose) with a value of 5 pieces. The treatment was not significantly different from the P1 and P2 treatments. On the other hand, the highest number of leaves was found in treatment P4 (Sludge dose 800 g/5 kg) with 8.67 leaves. The P4 treatment was not significantly different from the P3 treatment (600 g/5 kg Sludge dose). Thus, it can be said that the effective dose to increase the number of leaves in the utilization of sludge was in the P3 treatment (Sludge dose 600 g/5 kg). Based on the results of the correlation test, the increase in sludge dose on the increase in mustard leaves after harvest showed a very strong relationship. This can be seen from the value of r = 0.92. This condition was presumably because the sludge contained sufficient N to support the growth of mustard leaves. This accelerated growth in the vegetative phase, especially in stems and leaves, is due to the fulfillment of N elements in plants. N plays an important role in the formation of leaves in the photosynthesis process. In addition, the nutrient N plays an important role in the preparation of chlorophyll [1]. Based on Figure 7 above, it can be seen that the pattern of increasing the number of mustard leaves in relation to the increase in sludge dose increased from treatment P0 to P1, then decreased in treatment P2, then increased in treatment P3 and P4. [10] stated that the use of paper waste sludge had no effect on the increase in the number of mustard leaves after harvesting. This difference is thought to be due to different sludge sources. This also causes the nutrient content in the sludge to be different.

**Wet Weigth of White Mustard Plant (Brassica rapa)**

The results of measurements of the wet weight of mustard plants after harvesting at different doses of sludge on the soil are shown in the following table and graph:

**Table 11:** The Effect of Different Doses of Sludge on Soil Growing Media on Wet Weight (g) White Mustard (Brassica rapa) at Harvest.

| No. | Treatment | Repetition (cm) | | | Total | Average |
|---|---|---|---|---|---|---|
| | | R1 | R2 | R3 | | |
| 1. | Dose 0 g (P0) | 12.21 | 17.33 | 15.27 | 44.81 | 14.94a |
| 2. | Dose 200 g (P1) | 17.23 | 19.21 | 25.34 | 61.78 | 20.59b |
| 3. | Dose 400 g (P2) | 22.23 | 21.23 | 24.21 | 67.67 | 22.56b |
| 4. | Dose 600 g (P3) | 37.76 | 38.66 | 36.28 | 112.70 | 37.57c |
| 5. | Dose 800 g (P4) | 43.21 | 38.76 | 39.23 | 121.20 | 40.40c |

Note: Numbers followed by the same letter in the same column are not significantly different in the BNT5% test

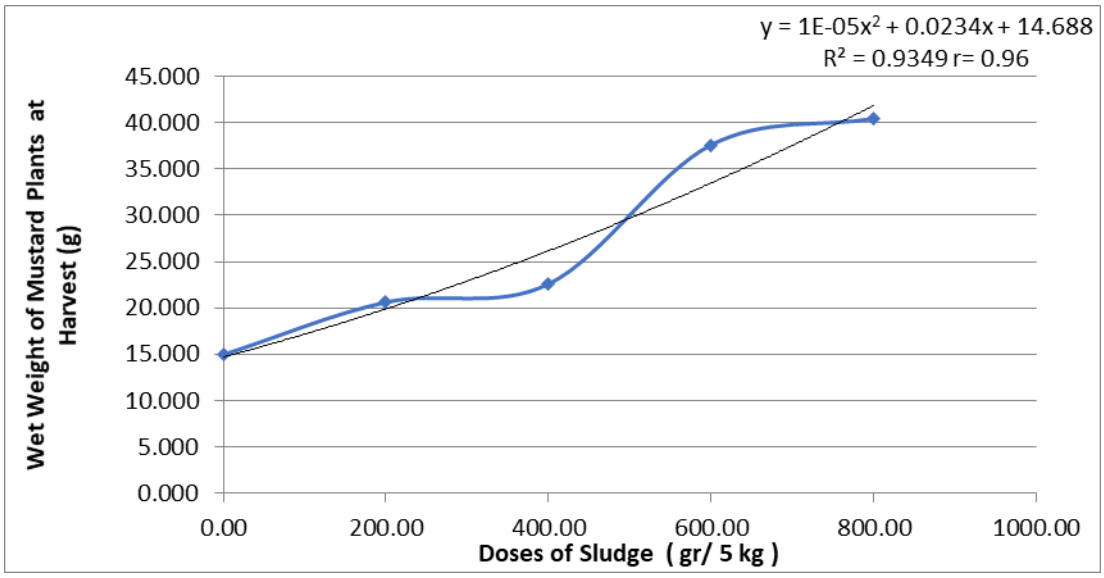


**Figure 8:** Relationship Between Increase in Sludge Dose and Wet Weight of Mustard Plants (g) At Harvest

From Table 11 above, it can be seen that the lowest wet weight of mustard after harvest was found in the P0 treatment (0.00 g/5 kg Sludge dose) with a value of 14.94 g. The treatment was significantly different from all existing treatments. Meanwhile, the highest wet weight was found in treatment P4 (Sludge dose 800 g/5 kg) with a weight of 40.40 g. The treatment was not significantly different from the P3 treatment (sludge dose 600 g/5 kg). Thus, it can be said that the effective dose for increasing mustard weight in sludge utilization was in the P3 treatment (Sludge dose 600 g/5 kg). This is because the treatment (only with 600 g sludge) did not show a significant difference with the treatment and P4 (800 g sludge). The high wet weight of mustard greens in the P3 and P4 treatments was thought to be due to the relatively large number of leaves compared to other treatments. Besides that, the sludge is also a source of N which supports leaf growth. This is in line with the opinion of [9], the availability of N in plants will facilitate plant metabolism, so that it affects the growth of organs such as stems, leaves and roots. Based on Figure 8 above, it shows a very strong relationship between the increase in

wet weight of mustard leaves and the increase in sludge dose. The relationship tends to increase from treatment P0 to P4. Based on the results of the correlation test showed a very strong relationship with the value of r = 0.96. This is in line with the opinion of [10] which stated that the combination of organic fertilizer and sludge had a significant effect on the wet weight of mustard greens without roots.

## 4. Conclusion

The results of testing the soil pH before and after the white mustard (Brassica rapa) were given the Sludge POME treatment showed that the soil pH after the treatment decreased compared to before the Sludge POME treatment. The difference in the value of the decrease in pH ranged from - 0.13 to - 0.20. The higher the dose of sladge POME, the higher the difference in the decrease in soil pH; Soil C-Organic before and after the mustard plants were given Sludge POME treatment showed that soil C-Organic after treatment decreased compared to before Sludge POME treatment. The difference in the decreasing value of C-Organic ranged from - 0.10 to - 0.21. The higher the dose of POME sladge, the higher the difference in C-Organic, but not in line with the P4 treatment with a dose of 800 g sludge/polybag; Soil nitrogen before and after mustard plants were treated with Sludge POME showed that soil nitrogen after treatment had an increase compared to before Sludge POME treatment. The difference in the increase in Nitrogen values ranged from -0.01 to 0.07. The higher the dose of sladge POME, the higher the Nitrogen difference; P-Available soil before and after the mustard plant was given Sludge POME treatment showed that P-Available soil after treatment had an increase compared to before Sludge POME treatment. The difference in the increase in the value of P-Available ranged from – 1.97 to 6.68. The higher the dose of sladge POME, the higher the P-Available difference; K-Available soil before and after mustard plants after being treated with Sludge POME shows that K-Availability of soil after treatment has increased compared to before Sludge POME treatment. The difference in the increase in the value of K-Available ranges from – 0.59 to 7.10. The higher the dose of sladge POME, the higher the K-Available difference; the height of the mustard plant after being given sludge treatment on the growing media soil showed that the height of the mustard plant increased with the higher dose of Sludge POME, with an average height ranging from 18.85 cm - 28.24 cm; the number of leaves of the mustard plant after being given sludge treatment on the soil of the growth media showed that the number of leaves increased with the higher Sludge POME treatment, with the average number of leaves ranging from 5.00 to 8.67; The wet weight of the mustard plant after being given sludge treatment on the soil of the growing media showed that the wet weight increased with the higher Sludge POME treatment, with an average basic weight ranging from 14.94 to 40.40 g.

## References

[1] Arnold C. Turang dan Jeaneke Wowiling, 2015. Manfaat Unsur Hara Bagi Tanaman. Balai Penelitian dan PerkembanganPertanian Sulawesi Utara

[2] Basith Heru Samba, Elza Zuhry, Sri Yoseva, 2018. Pengaruh Limbah Padat Pabrik Kelapa Sawit dan Pupuk P terhadap Pertumbuhan dan Produksi Tanaman Kedelai (glycine max l. Merrill). Jurusan Agroteknologi, Fakultas Pertanian, Universitas Riau.

[3] Budianta D. 2004. Pengaruh pemberian limbah cair pabrik kelapa sawit untuk pupuk cair terhadap

kualitas air. Jurnal Pengelolaan Lingkungan & SDA. 2(3):147-154.

[4] Budianta D. 2005. Potensi limbah cair pabrik kelapa sawit sebagai sumber hara untuk tanaman perkebunan. Jurnal Dinamika Pertanian. 20(3):273-282.

[5] Deublein D, Steinhauster A. 2008. Biogas from Waste and Renwable Resources. Winley-VCH Verlag GmbH & Co. KGaA. Wetnhetm.

[6] Hartley CWS. 2004. Environmental impact of oil palm plantations in Malaysia. Palm Oil Research Institute of Malaysia (PORIM). Occasional Paper. 33:1-27.

[7] Ibe IJ, Oblige JN, Orji Jc, Nwanze PL, Ibejisika C, Okechi BN. 2014. Effects of palm oil mill effluent (POME) on soil bacteria andenzymes at different season. Int. J. Curr Microbial. App. Sci. 3(10): 928-934.

[8] Hamsyin, 2020. Analisa Unsur Hara Makro Pada Sludge POME Hasil Perlakuan Dengan Koagulan Alami Biji Kelor (Moringa oleifera). Laporan Penelitian Mandiri, Fakultas Pertanian, Universitas Mulawarman, Samarinda

[9] Hidayat, S. 2009. Protein Biji Kelor Sebagai Bahan Aktif Penjernihan Air. Biospecies. 2(2): 12 – 17.

[10] Inayah Fitri, Herlina Fitrihidajati, Yuni Sri (2016) Efektivitas Kompos Berbahan Dasar Lumpur Pabrik Kertas dengan Penambahan Trichoderma Harzianum terhadap Pertumbuhan Tanaman Sawi (brassica chinensis var. Pakchoi). Jurnal Wiyata Suranaya.

[11] I .G. P. A. Suryawan, I.G. A. K. D. D. Hartawan, I. P. K. Kencanawati, 2016. Kandungan Unsur Nitrogen dan Karbon pada Kompos dari Bahan Baku Sampah Organik yang Dicacah dengan Mesin Pencacah. Fakultas Teknologi Pertanian Universitas Udayana, Jurnal Udayana Mengabdi, volume 15 Nomor 1.

[12] Laimeheriwa, B.M. 2017. Mekanisme Fiksasi Karbon, Fiksasi Nitrogen Dan Metabolisme Fosfat Di Laut. https://www.researchgate.net/ publication/ 320881782. Working Paper. 1-26 p.

[13] Muhammad Fiqi Syaifuddin dan Belly Adhitya Hizkia Destantyo, 2018. Pembuatan Pupuk Organik dari Limbah Pertanian Dengan Metode Aerob dan Anaerob. Departemen Teknik Kimia Fakultas Teknologi Industri Institut Teknologi Sepuluh Nopember Surabaya (skripsi)

[14] Pandapotan, C.D., Mukhlis, dan P. Marbun. 2017. Pemanfaatan Limbah Lumpur Padat (Sludge) Pabrik Pengolahan Kelapa Sawit Sebagai Alternatif Penyediaan Unsur Hara Di Tanah Ultisol. Jurnal Agroteknologi. 5 (2): 271 – 276.

[15] Priyambada,G. 2015. Studi Pemanfaatan Lumpur, Abu Boiler, Serat (Fiber) Kelapa Sawit Sebagai Kompos Menggunakan Variasi Effective Microorganism (Em-4).Fakultas Teknik.Universitas Riau.Pekanbaru.

[16] Sari, R.K.,L. Tinadan A.F.Fachlevy(2017).Efektifitas Biji Kelor (MoringaOleifera) Terhadap Bakteri Escherichia Coli Dalam Upaya Pencegahan Penyakit Diare.JurnalIlmiahKesehatanMasyarakatUnsiyah. 2(6): 6-7.

[17] Wardayati K. Tatik. 2020. Begini Manfaat Biji Kelor dalam Penjernihan Air dan Cara Pemakaiannya. Intisari Online.