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Composition Analysis of Bokashi Organic Fertilizer from Fish Flour Fishery Waste

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ABSTRACT

Dead fish after upwelling in Cirata Reservoir might cause environmental pollution if it is not well managed. A solution that can be used is utilizing the waste into bokashi organic fertilizer. The purpose of this research were to process fish wastes into bokashi organic fertilizer that meet standards of SNI, and to apply on kale growth. Research was divided into three stages. The first stage was production of fish meal from Cirata Reservoir fisheries waste. The second stage was production of bokashi organic fertilizer by mixing fish meal, rice bran and coconut dregs with fish meal concentration of 30%, 40%, 50% and 60%. The third stage was fertilizer application on kale. Bokashi organic fertilizer product had organic C of 13,98%-17,77%, N total of 3,23%-7,80%, C/N ratio of 1,69- 5,50, P total of 1,46%-2,90%, and K total of 0,92%-1,46%. In general, bokashi organic fertilizer product did not meet standard of SNI because C/N ratio was below the standard. Bokashi organic fertilizer with 30% fish meal combination resulted the highest kale growth ($p < 0,05$).

***Keywords**: Bokashi Organic Fertilizer; Cirata Reservoir; Fisheries Waste; Fish Meal.*

INTRODUCTION

The very rapid development of KJA in Cirata Reservoir contributes residual feed and fish metabolism products that tend to increase nutrients in waters so as to accelerate eutrophication (Komarawidjaja, 2005). The fish waste still contains a fairly high level of organic nutrien. This high content of organic nutrients when in water bodies will cause eutrophication in public waters, which will then lead to the death of organisms living in water such, silting, algae fertilization and uncomfortable odors (Ibrahim, 2005). The accumulation of feed residues and high metabolic waste will reduce fishery resources during *upwelling* in the Cirata Reservoir (Syafei, 2005).

The dead fish becomes waste that has a low economic value because it is not suitable for direct consumption by the community. To increase the economic value of the waste, a waste treatment business is needed into a product that has added value for the community. One form of fishery waste is made organic fertilizer with raw materials for fishery waste.

The current lifestyle of modern society that leads to a healthy and organic lifestyle causes foodstuffs derived from organic agriculture and animal husbandry such as organic rice, vegetables organic, organic eggs and other foodstuffs are commodities that are hunted by the community. The increasing demand for organic agricultural products, the need for organic fertilizers has also increased so that currently banyak developed the technology of making organic fertilizers derived from raw materials that are easy to obtain, require little capital and are easy to be mass-produced (Aguilera *et al*. 2013). One type of organic fertilizer that was widely developed during ini is bokashi. Bokashi is a fertilizer produced from the fermentation or fermentation process of organic materials with EM (*Effective Microorganism*) technology (Xiaohou *et al*. 2008).

The advantage of EM technology is that organic fertilizers can be produced in a relatively short time compared to conventional means. EM is a combination of several bacteria and fungi, for example lactic acid bacteria, phototropic bacteria, yeast, fermentasi fungi and group bacteria

Actinomycetes, which have the ability to fertilize plants and decompose organic matter The raw material for making bokashi fertilizer is agricultural waste such as hay, grass, husk, legume plants , manure atau sawdust, but the best material used is rice bran because of its good nutritional content for the growth of microorganisms (Mayer *et al*. 2010).

The purpose of this study is to determine the best quality of organic fertilizer produced by looking at the nutrient content contained in the fertilizer, and determining the best fertilization treatment by looking at the growth of the land kale plant (*Ipomoea reptana*).

METHOD

The main material used in the study was fish waste obtained from the Cirata Reservoir, Cianjur. Other materials used include rice bran, coconut pulp, EM-4, molasses, aqueous, land kale plant seeds, soil, *polybags*, urea, KCl, SP36, water, soil, *polybags*, aqueducts, H_2SO_4, NaOH 30%, H_3BO_3 2%, HCl 0.01 N, $K_2Cr_2O_7$ 2 N, $FeSO_4$ 0.2 N, $KMnO_4$ 0.1 N, and $Cl_3La.7H_2O$.

The tools used in the study include *Atomic Absortion Spectrophotometer* (Shimadzu AA-680), *Spectrophotometer* (LW-200 Series), oven (Memmert), digital scales (OHAUS), furnace (Nabertherm), *chopper* (Misaka), *leaf area meter* (Delta-T Devices), plastic container, sack, pH *tester* , thermometer, Erlenmeyer flask, weigh bottle, desiccator, porcelain cup, volumetric pipette, drip pipette, burette, water bath, *Kjeldahl* flask, and filter paper.

The stages of research carried out consist of 3 stages. The first stage is the manufacture of fish meal, the second stage is the manufacture of bokashi organic fertilizer, and the third stage is the application of bokashi organk fertilizer to land kale plants.

The manufacture of fishmeal refersto Deng *et al*. (2006) begins with fish washing to remove adhering dirt and blood. Whole fish waste is ground using *a chopper* to reduce the particle size of the waste. The waste is then dried by drying in the sun for $\pm$2 days to reduce the water content by up to 20% and then the scavenging process is carried out. Fish waste that has been dried is mashed with a *grinder* and then filtered using a sieve so that fish meal with homogene granules is obtained. The resulting fishmeal will be carried out proximate and macronutrient analysis (N-Total (BSN 1992), P_2O_5, C-Organic, K_2O (AOAC 2007), and C/N ratios.

The making of bokashi organic fertilizer refers to Sutanto (2002) which begins with the preparation of raw materials , yes, it is rice bran, coconut pulp and fish meal. Raw materials are first dried in the sun to reduce their moisture content. The formulation of the manufacture of bokashi organic fertilizer is presented in Table 1. Raw materials with a predetermined composition, mixed in a plastic basin container and stirred thoroughly.

The mixture of raw materials is then added em solution that has been activated with a mixture of water and molasses with a ratio of water: molasses: EM of 90: 5: 5 as much as 10% (w/v) of the weight total fertilizer. A solution of secara is slowly poured into the mixture until the mixture has a moisture content in the range of 40-50%. Mixtures that have a moisture content of 40-50% have a characteristic if when the mixture is kneaded, the mixture becomes fused. The moisture content is controlled on the 10th day to conditionthe fixed moisture content to range from 40-50%. The mixture is placed in a plastic sack to protect the mixture from dust and water, and conditioned in an aerobic atmosphere to support the composting process. The pH and temperature values are measured daily as long as the mixture is composted under aerobic conditions. The temperature of the mixture is measured routinely and maintained at about 35-45ºC. The mixture must be stirred if the temperature reaches 45ºC in order for the temperature to drop again. The benefits of bokashi will be reduced when the temperature of bokashi exceeds 50ºC because the energy in making bokashi will be lost by up to 50% along with high heat release, and a temperature of 50ºC can kill the composting microbes contained in EM so that the composting process does not run optimally. The composting process is carried out for 18 days. After the composting process is complete, bokashi fertilizer is dried in the sun until it is slightly dry and then analyzed the moisture content and macro nutrients including the ratio of C / N, organic carbon, total nitrogen, phosphorus and potassium content that can be exchanged.

The resulting fertilizer is then applied to land kale plants (*I. reptana*). Land kale plants are planted in *polybags* measuring 35 x 35 cm and filled with soil as much as 3 kg. The land kale seeds used were 0.018 g / *polybag*. A seedling of 0.018 g will produce anakan of land kale as much as 15-20 stems. Such seedlings are first sown for 2 weeks. The saplings of land kale plants are then transferred to *polybags* (calculated as 0 MST (Week After Planting)) after 2 weeks, fertilization is carried out at the time of planting in *polybags* before the kale saplings are planted.

Table 1. The composition of raw materials for the manufacture of bokashi organic fertilizer

Treatment Code	Composition (%)		
	Rice bran	Coconut pulp	Fish meal
P_0	0	0	100
P_1	50	20	30
P_2	40	20	40
P_3	30	20	50
P_4	20	20	60

The land kale plant was then harvested when it was 4 MST (Susila 2006). The parameters observed in the growth of land kangkong are the growth rate of the anaman height, the number of leaves, and the weight of the plant.

RESULT AND DISCUSSION

Hasil penelitian dideskripsikan terlebih dahulu untuk memudahkan pemahaman dan pembacaan data, kemudian dilanjutkan dengan pembahasan. SubBab hasil dan subBab pembahasan disajikan secara terpisah. Hasil analisis data harus dapat diandalkan dalam menjawab permasalahan penelitian. Tabel atau grafik harus menyajikan hasil yang berbeda dalam memperjelas data yang bersifat uraian sebagai bentuk efisiensi. Bagian pembahasan hendaknya memuat manfaat hasil penelitian, bukan mengulang dari paparan data. Perbandingan temuan studi sebelumnya harus disertakan dan didiskusikan dalam subBab pembahasan. Bagian ini harus menjadi bagian yang paling banyak, minimum 60% dari keseluruhan badan artikel. Font size 11 pt.

Characteristics of Raw Materials

The resulting fish meal has a moisture content of 7.60%, ash content of 22.34%, fat content of 16.69%, protein content of 55.52%, C-or ganik of 9.36%, Total N of 9.63%, ratio value C/N of 0.97, total K of 0.30% and total P of 3.26%. The results of the proximate analysis and nutrient content of raw materials are presented in Table 2. The total nitrogen and total phosphorus of fish meal produced is quite high, namely 9.63% and 3.26%, which shows that the fish meal produced is quite potential as a source of nitrogen and phosphorus for bokashi organic fertilizer . The nitrogen content suggested for organic fertilizer raw materials is $\geq$ 3%, while for phosphorus, which is $\geq$ 0.5% (Sutanto 2002).

Table 2. The composition of raw materials for the manufacture of bokashi organic fertilizer

Parameters	**Raw Materials**		
	Fish meal	**Rice bran**	**Coconut pulp**
Proximate			
Water (%)	7.60±0.04	10.51±0.09	70.52±0.36
Ash (%)	22.34±0.28	11.16±0.64	0.24±0.01
Fat (%)	16.69±0.02	12.39±0.21	3.75±0.19
Protein (%)	55.62±0.06	29.51±0.56	5.85±0.04
Macro nutrients			
C-organic (%)	9.36±0.20	11.68±0.11	7.85±0.14
Total N (%)	9.63±0.01	5.28±0.10	0.93±0.01
C/N ratio	0,97	2,21	8,44
Total K (%)	0.30 ±0.00	0.54±0.01	0.63±0.01
Total P (%)	3.26±0.08	0.53±0.00	0.03±0.00
Source: Processed Data			

Changesin Temperature during composting Process

Temperature changes during the composting process are indicated by the presence of an increase in temperature at the initial stage of the process and tend to decrease at the next stage. The temperature changes that occur during the composting process are presented in Figure 1. The pattern of temperature change during the composting process at treatment P_1, P_2, P_3 and P_4 has the same pattern tendency, while the P_0 treatment has a pattern which is different from other treatments. The greater the composition of fish meal used in the manufacture of fertilizer, the greater the resulting temperature change.

Thedifference in the pattern of temperature changes in each treatment is caused by differences in carbon availability which will affect microbial activity during the composting process. Goyal *et al*. (2005) states that carbon compounds in the composting process are used by composters as a source of energy or fuel to remodel complex organic compounds into a form that can be utilized by plants. Microbes will release thermal energy during the overhaul process which causes a rise in temperature. The availabilityof carbon in the P_0 treatment is only limited from fishmeal which has a low C-organic content so that the activity of decomposing microbes is not optimal, while the treatment is P_1, P_2, P_3 and P_4 which have more carbon availability due to the contribution of rice bran as an additional carbon source so as to allow microbes to have a more optimal activity.

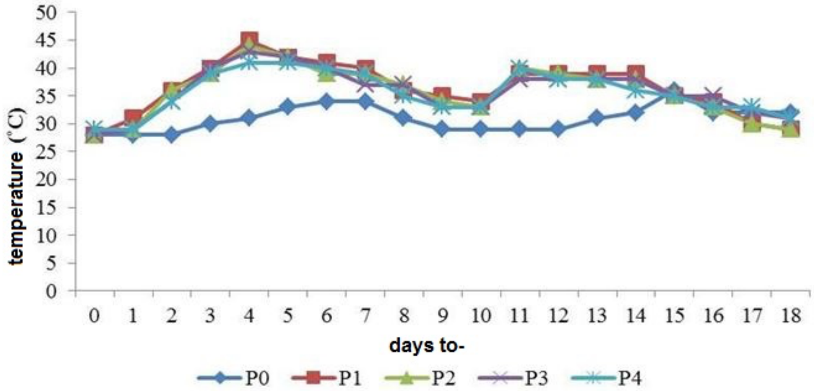

Figure 1. Temperature changes of bokashi fertilizer during the composting process

The temperature increaseatan at the beginning of the composting process occurs due to the activity of the mikroba in decomposing the material so as to produce energy in the form of heat that is released into the environment (Pramaswari *et Al.* 2011). The decrease in temperature in the next stage is due to a decrease in microbial activity (Laos *et al*. 1998). The stage of temperature drop is called the cooling stage. The process of evaporation of water from the composted material will continue until the refinement of humus formation during the cooling process (Kastaman *et al.* 2006).

pH Changes during the Composting Process

Changes in pH during the composting process are indicated by a decrease in pH at the initial stage of the process and tend to increase at the next stage until it reaches a neutral pH. The change in pH that occurs during the composting process is presented in Figure 2.

Changes in pH during the composting process showed the same trend for all treatments, namely a decrease in pH at the beginning of the composting process to the lowest pH point on day 5 and then the pH increased until it is close to the normal pH on the 18th day. This is in line with the statement of Sutanto (2002) who states that in general, the pH during the n-cloting process will drop at the beginning of the composting process due to the activity of bacteria that produces acid.

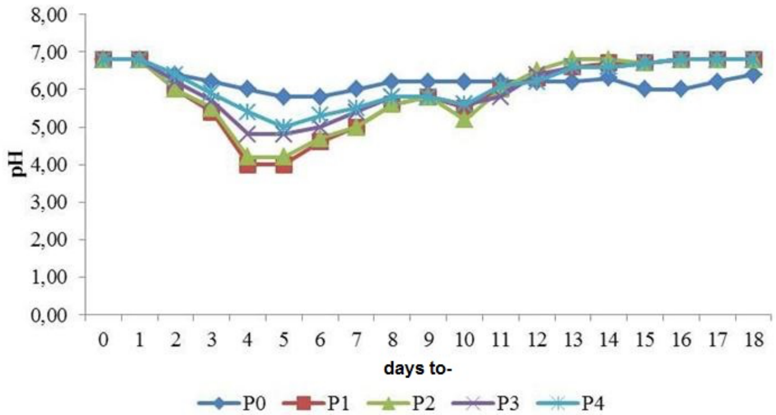

Figure 2. Changes in pH during the composting process

Other microorganisms of the decomposed material, namely protein spear bacteria, then the pH will rise again after a few days and the pH will be at a neutral state at the end of the composting process. The rise in pH is also triggered by the overhaul of complex nitrogen into nitrogenous bases by microbes (Wei *et al*. 2000)

Organic C Content

All treatments have an organic C content ranging from 13.17%- 17.77%. This value shows that the organic fertilizer produced has met the organic C value of the BSN rut menu (2004) which is 9.80-32.00%. The results of the analysis of the organic C content of the resulting organic fertilizer are presented in Figure 3.

The P_1 fertilizer treatment has the highest organic total C value, while the P_0 pupu k has the lowest organic C value. This can be caused by fertilizer P_1, fish waste added is lower in concentration (60%) than in other fertilizers so that the proportion of other additional raw materials is rice bran as a source of additional karbon is higher. Graves *et al.* (2000) states that carbon is used as an energy source for microbial growth. The availability of organic carbon will affect the activity of microbes in overhauling other macromolecules such as proteins.

AnN Total

All treatments have a total N content ranging from 3.23%- 7.80%. This value shows that the organic fertilizer produced has met the total N content according to BSN (2004), which is > 0.40%. The results of the analysis of the total N content of organic fertilizers producedn are presented in Figure 4.

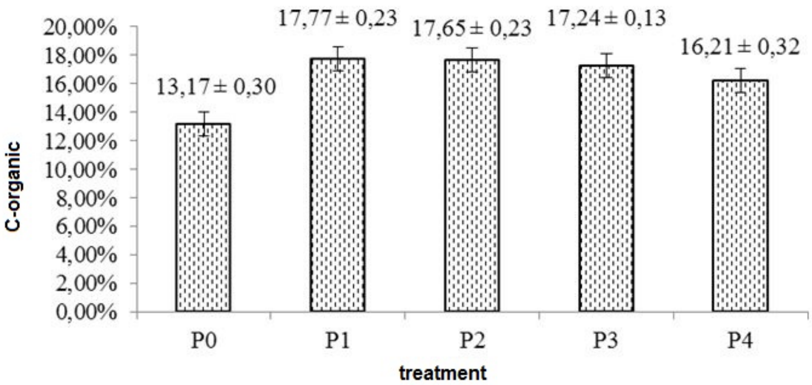

Figure 3. The total content of organic C in the bokashi organic fertilizer produced

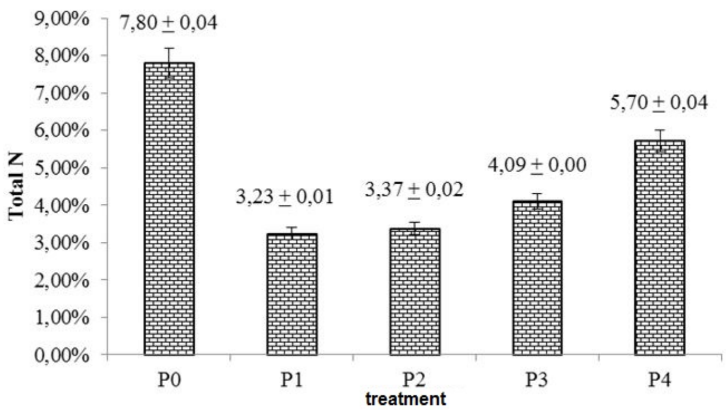

Figure 4. Total N content in the bokashi organic fertilizer produced

P_1 fertilizer treatment has the lowest total N value, while P_0 fertilizer treatment has the highest total N value. This can be because P_0 fertilizer has the highest composition of fish meal as a source of nitrogen (100%) compared to other fertilizers, so P_1 fertilizer has a composition the smallest fish meal

(30%). Supadma and Arthagama (2008) stated that the higher the N content of the base material, the easier it is to experience the level of decomposition, and produce the N content of the total compost which is increasing tinggi. Lack of nitrogen in the soil causes plant growth to be disturbed and plant yields to decrease due to the formation of chlorophyll which is essential for the photosynthetic process is disturbed (Usman 2012).

C/N Ratio Value

All treatments had C/N ratio values ranging from 1.69-5.50. The C/N ratio value of organic fertilizers produced has not met the C/N ratio value according to BSN (2004) which is 10-20. The C/N ratio value of the resulting organic fertilizer is presented in Figure 5. Low C/N ratio values can be caused by oleh nitrogen-rich raw materials. If the C/N ratio value is too low due to nitrogen-rich raw materials, then carbon will become a limiting nutrient or nutrient absorption activity will be limited by the carbon content of the material (Graves *et al*. 2000). Excess nitrogens (N) that are not used by microorganisms cannot be assimilated and will disappear through volatization as ammonia or denitrated if the C / N ratio is too low (less of 30) (Ndegwa and Thomson 2000).

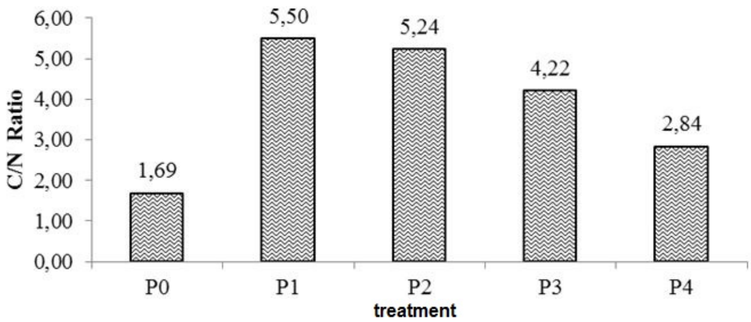

Figure 5. C/N ratio value in the resulting bokashi organic fertilizer

P content (Phosphorus)All treatments have a P content ranging from 1.46%-2.90%. All organic fertilizers produced have met the P content according to BSN (2004), which is > 0.20%. The P content of the resulting organic fertilizer is presented in Figure 6.

P0 fertilizer treatment has the highest P content, while P1 fertilizer treatment has the lowest P content. This can be because fertilizer P_0 has a higher composition of fish meal as a source of N (100%) compared to other fertilizers. Hidayati *et al.* (2008) stated that the P content in fertilizers can be related to the nitrogen content in the material. The greater the nitrogen contained, the multiplication of microorganisms that overhaul P will increase, so that the P content in the material also increases, as well as the P containment in fertilizer along with the content of P in the material.

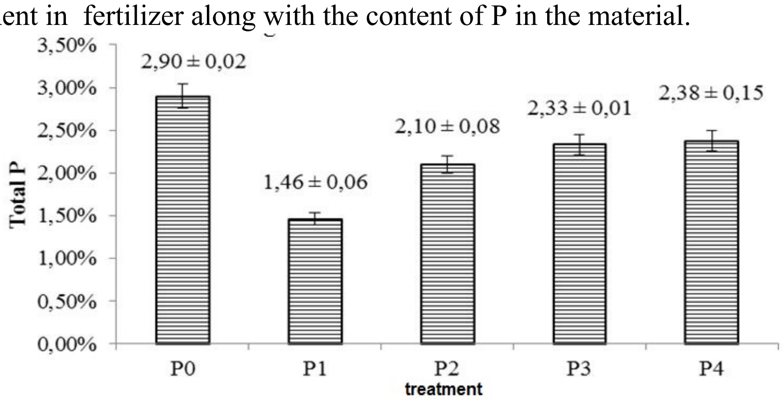

Figure 6. P content in the bokashi organic fertilizer produced

K (Potassium) Content

All treatments have a K content ranging from 0.92%-1.48%. The K content of organic fertilizer produced has not met the K content according to BSN (2004), which is >0.10%. The K content of the resulting organic fertilizer is presented in Figure 7.

The P_1 fertilizer treatment has the highest K content, while the P_0 fertilizer treatment has the lowest K content. This can be because P_1 fertilizer has the lowest composition of fish meal (30%) compared to other treatments so that the proportion of other raw materials, namely rice bran and coconut pulp as a source of K is higher. Hidayati *et al.* (2008) states that potassium is used by microorganisms in materials as a catalyst, with the presence of bacteria and their activity, greatly affecting the increase in candid gan potassium.

Growth Rate of Land Kale Plant

Duncan's follow-up test showed that the P_1, P_2 and K_P (positive controls) treatments had the best growth rates and had a markedly different effect on the treatment others (K_N, P_0, P_3, P_4). The difference is due to the difference in the C/N ratio value of each bokashi fertilizer produced. The value of the C/N ratio indicates the degree of maturity of the fertilizer. If the C/N ratio value is too low due to nitrogen-rich raw materials, then carbon will become a limiting nutrient or nutrient absorption activity will be hampered and limited by levels carbon. A C/N ratio that is too low can also inhibit the absorption of other nutrients so that it can inhibit plant growth (Crawford 2003). The rate ofgrowth of land kale plants is presented in Figure 8

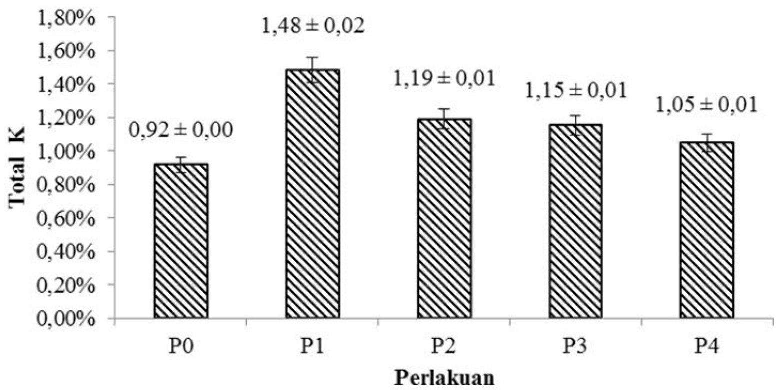

Figure 7. K content in the resulting bokashi organic fertilizer

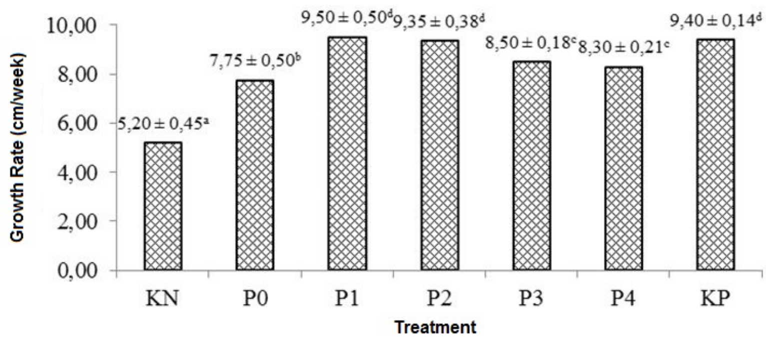

Figure 8. Growth rate of land kale plant

High of the Land Kale Plant

Duncan's follow-up test results showed that the P_1, P 2 and K P treatments (positive controls) had the best plant height and had a markedly different effect on the treatment others (K_N, P_0, P_3, P_4). Just like the rate of growth, the difference is due to the difference in the C/N ratio value of each bokashi fertilizer produced. The value of the C/N ratio indicates the degree of maturity of the fertilizer. If the C/N ratio value is too low due to nitrogen-rich raw materials, then carbon will become a limiting nutrient or nutrient absorption activity will be hampered and limited by levels carbon. A C/N ratio that is too low can also inhibit the absorption of other nutrients so that it can inhibit plant growth and development (Crawford 2003). The height of the land kale plant is expressed in Figure 9.

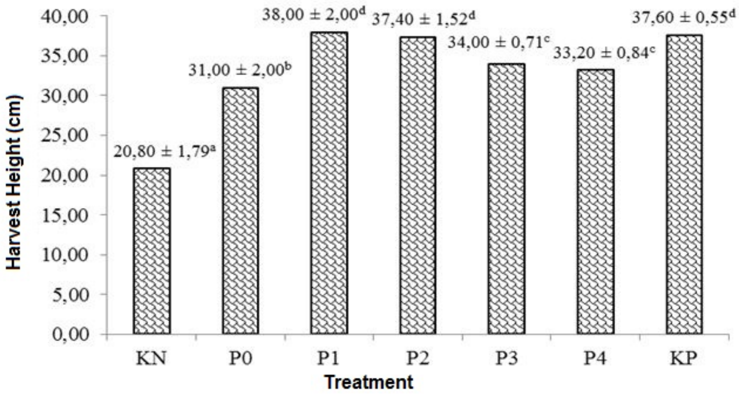

Figure 9. Harvest Height of Land Kale Plant

Average Number of Leaves of Land Kale Plant

Duncan's test results showed that all fertilization treatments with bokashi organic fertilizer could increase the number of leaves of caisin plants at 1, 2, 3, and 4 MST. The highest number of leaves is found in the treatment of organic fertilizers during harvest (4 MST). Duncan's lanjut test results showed that there was a markedly different influence between the treatment of bokashi fertilizer (P 0, P 1, P 2, P 3, P 4) and chemical fertilizer (K P) against no fertilization (K_N) at 3 MST and 4 MST on the number of leaves of the land kale plant. This is because fertilizing is able to provide a sufficient supply of nutrients for leaf growth. Nutrients in the K_N treatment that only come from the soil are suspected to be unable to meet the nutrient needs needed by land kale plants until the end of the planting period so that the number of leaves that grow becomes small, even begins to fall when entering 4 MST because it only depends on limited nutrients from the soil that not fed with fertilizer. Sufficient nutrient asupan element will support optimal growth of seraca plants , but if nutrient intake is not able to meet plant needs, then growth the plant will be stunted and even die from lack of food (Ruhnayat 2007). The number of leaves indicates the growth of a plant, the more the number of leaves produced by the plant, the better the growth of the plant (Subowo *et al.* 2010). The number of leaves of the land kale plant is presented in Figure 10.

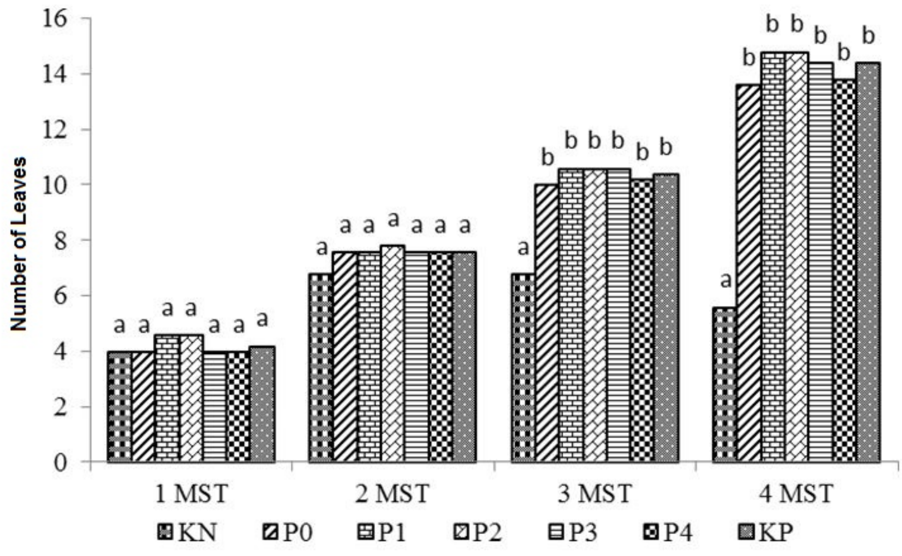

Figure 10. Number of leaves of the land kale plant

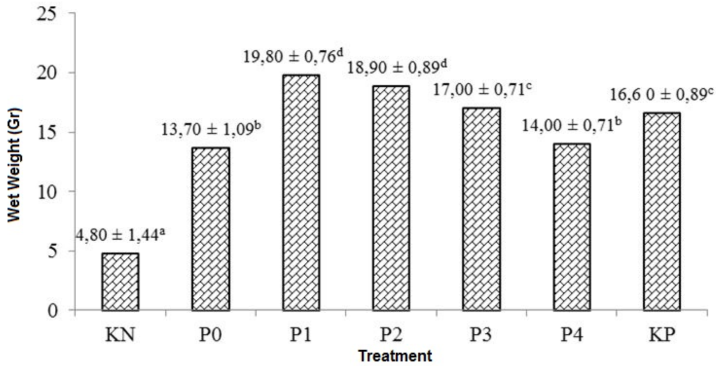

Figure 11. Weights of land kale plants

Weight of Land Kale Plant

Duncan's further test results showed that the P 1 and P 2 treatments had the best plant weights and had a markedly different effect on other treatments (K N, P 0, P 3, P $_4$, K_P). Just like the growth rate and plant height, the difference is due to the difference in the C/N ratio value of each bokashi fertilizer produced. The value of the C/N ratio indicates the degree of maturity of the fertilizer. Carbon will be a limiting nutrient or nutrient absorption activity will be hampered and limited by carbon levels and the value of the C/N ratio is too low because the raw materials are rich in nitrogen. The C/N ratio that is too laceh can also inhibit the absorption of other nutrients so that it can inhibit plant growth and development (Crawford 2003). Santoso *et al.* (2012) states that applying fertilizers with sufficient NPK content can increase plant weight and can provide maximum P and K absorption for plants. The weight of the land kale plant is presented Figure 11.

CONCLUSION

Fish waste can be used as raw material for making bokashi organic fertilizer. The best fertilizer based on nutrient content is P_1 fertilizer (30% fish meal) which has the highest organic K and C content and the C / N ratio value is closest to the standard value. Fertilizer based on the growth of land kale plants is P_1 fertilizer (30% fish meal) which results in better growth rate, plant height and plant weight compared to other treatments.

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