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SHORT COMMUNICATION

Utilization of Leaves in Mine Reclamation Land as Organic Fertilizer with Bioactivatory of Efecctive Microorganism 4 (EM4) and Molasses

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Organic fertilizer as a potentialn alternative to reduce the scarcity of chemical fertilizers, furthermore, it can improve soil fertility. PT Semen Gresik - Semen Indonesia Persero (Tbk.) has a lot of plants in the treatment period in ex-mining land that needs fertilizer to help plant growth. In addition, in post-mining land, there is a lot of organic waste in the form of dry leaves under the stands of reclamation trees. The organic waste has the potential to be processed and used as organic fertilizer. The aims of this study was to determine the doses of molasses and EM4 as bioactivators in the manufacture of organic fertilizer made from leaf litter in mine reclamation land. This study is a laboratory experimental method. The results showed the composition of solid material in the form of leaf litter, bran, cow dung and husk charcoal in a ratio of 2: 1: 1: 1. The composition of molasses and EM4 with a dose of 100 mL per 100kg of solid material, respectively, dissolved in enough water (fertilizer can be clenched and expanded slowly and not broken). As conclusion composition dose molasses and EM4 as bioactivators in the manufacture of organic fertilizer made from leaf litter mine reclamation land 100 mL per 100 kg (ratio 1:1) with the characteristics of the microbial composition of *Lactobacillus* sp., *Streptomyces* sp., Yeast, *Rhodopseudomonas* sp., *Actinomycetes* sp. with brown EM4 color indicator, sour smell, pH 3.5, and the most nutrient content is organic C.

Key words: EM4, leaf litter, mine reclamation land, molasses, organic fertilizer

Pupuk organik sebagai alternatif untuk mengurangi kelangkaan pupuk kimia, selain itu dapat memperbaiki kesuburan tanah. PT Semen Gresik - Semen Indonesia Persero (Tbk.) memiliki banyak tanaman dalam masa perawatan pada lahan bekas tambang yang membutuhkan pupuk untuk membantu pertumbuhan tanaman. Disamping itu, pada lahan pasca tambang banyak sampah organik berupa dedaunan kering dibawah tegakan pohon reklamasi. Sampah organik tersebut berpotensi untuk diolah dan dimanfaatkan sebagai pupuk organik. Tujuan penelitian ini untuk mengetahui dosis EM4 dan molase sebagai bioaktivator dalam pembuatan pupuk organik berbahan dasar serasah daun di lahan reklamasi tambang. Metode penelitian yang di gunakan adalah metode eksperimen laboratoris. Hasil penelitian menunjukkan komposisi bahan padat berupa serasah daun, dedak, kotoran sapi dan arang sekam dengan perbandingan 2:1:1:1; bahan berupa molase dan EM4 dengan takaran masing-masing 100ml per 100kg bahan padat yang dilarutkan dalam air secukupnya (pupuk dapat dikepal dan mengembang dengan pelan-pelan serta tidak pecah). Sebagai kesimpulan komposisi dosis EM4 dan molase sebagai bioaktivator dalam pembuatan pupuk organik dari serasah daun di lahan reklamasi tambang masing-masing 100 ml per 100 kg (1:1) dengan karakteristik komposisi mikrobanya *Lactobacillus* sp., *Streptomyces* sp., Yeast, *Rhodopseudomonas* sp., *Actinomycetes* sp. dengan indikator warna EM4 coklat, baunya asam, pH 3,5, dan kandungan nutrient yang terbanyak C organik.

Kata kunci: EM4, lahan reklamasi tambang, molase, pupuk organik, sersah daun

The use of organic fertilizers can reduce dependence on chemical fertilizers whose availability is increasingly rare and expensive. It can also reduce the occurrence of environmental pollution. Organic matter is known to improve the physical properties of the soil by improving soil structure, where the lumpy soil can become more loose so it is more easily penetrated by plant roots. In soils with high clay content, organic matter will be able to facilitate soil management, by improving groundwater passing and increasing water retention capacity from the soil. This will cause the soil to provide more water, especially in the dry season. Organic matter can also improve soil chemical properties such as: increasing the capacity of cation exchange (exchange of nutrients or nutrients for

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plants) more easily and smoothly, providing plant nutrients in the form of P, K, Ca, Mg, S, and elements other micro elements that are needed by plants. Organic matter can improve the soil's biological condition so that the soil remains alive, durable and resistant to shocks that cause soil damage. Besides organic matter can increase the efficiency of the use of chemical fertilizers, so as to reduce the cost of purchasing chemical fertilizers. Thus, organic fertilizer can increase agricultural production both in quality and quantity, and improve the quality of land in a sustainable manner. The use of organic fertilizer in the long term can increase land productivity and can prevent land degradation (Simanungkalit 2006).

Organic fertilizers have some advantages even though they also have limitations. Some of the advantages of organic fertilizers are (a) organic fertilizers that contain complete nutrients, both macro nutrients and micro nutrients, (b) organic fertilizers contain organic acids, including humic acids, fulfill acids, hormones and enzymes that are not present in artificial fertilizers which are very useful both for plants and the environment and microorganisms, (c) organic fertilizers containing macro and soil microorganisms which have a very good influence on the improvement of soil physical properties and especially soil biological properties, (d) organic fertilizers can improve and maintain soil structure, (e) organic fertilizer can be a buffer of soil pH, (f) organic fertilizer can be a buffer of inorganic nutrients provided, (g) organic fertilizer can help maintain soil moisture, (h) organic fertilizer is safe to use in large quantities and even though, (i) organic fertilizer does not damage the environment. In addition to these advantages, organic fertilizer can also provide economic value to a variety of household and agricultural wastes (Wahyuni 2016).

Reclamation and revegetation of former mines is an obligation that must be carried out Minister of Regulation Energy and Mineral Resources Republic Indonesia 2014. Decree No. 7 of 2014 The success of a reclamation is very much determined by many things, including aspects of land management, fertility of the planting media, technical planting and care of plants. PT. Semen Gresik - Semen Indonesia Persero (Tbk.) has a lot of plants in the treatment period in ex-mining land that needs fertilizer to help plant growth. In addition, in post-mining land, there is a lot of organic waste in the form of dry leaves under the stands of reclamation trees. The organic waste has the potential to be processed and used as organic fertilizer. The purpose of this study is to utilize leaf litter in the reclaimed mine land as organic fertilizer with EM 4 and Molasses bioactivators.

This research is a laboratory experimental study, which was carried out in the biology laboratory and in the Semen Indonesia Tuban plant. The equipment needed in this research is pock, shovel, ziplock plastic, pH meter, thermometer, GPS, camera, moisture meter, tarpaulin, and gloves. While the materials needed in this study are water used to dissolve molasses and EM4, soil or media used in the process of reclamation of ex-limestone quarrying land, leaf litter taken on reclaimed land of former limestone quarrying, charcoal, fine charcoal, dirt cattle or animal manure, molasses or molasses and Em4.

Leaf Litter Sample Testing. Leaf litter samples were taken from the reclaimed land of the former limestone quarry in 2010, 2014 and 2016, where each sample was taken twice (duplo repetition). Furthermore, the quality of leaf litter was tested based on parameters namely P Total (P2O5) by method Olsen and Bray, K Total (K2O) by method Spektrofotometri, Organic C by method Walkey and Black, and Nitrogen (N) by method Destilasi in the laboratory.

Organic Fertilizers. Making organic leaf litter fertilizer by the bokashi method (York, 2014) begins with taking leaf litter in the reclaimed land of the former limestone quarry. The leaf litter is then put into the leaf chopper machine. The leaf chopper used is a regular chopper (or compost chopper) that has a capacity of chopping 100kg / hour with a diesel engine powered by diesel. The resulting leaf counts are weighed according to the fertilizer manufacturing plan which is 40% of 100% of the total material so that the leaf counts needed are as much as 40 kg of the total 100 kg of fertilizer. The mixture of solids is watered evenly with a bioactivator solution. Bioactivators EM4 and molase play a role in accelerating the fermentation process and increasing the nutrient content contained in leaf litter because with biocivators speeding up the fermentation process. The flat mixture is then put into a tarp and covered with tarps for ± 21 days. During the process the temperature is maintained less than 50ºC.

Organic Fertilizer Testing. Testing the quality of organic fertilizers that have been produced is done by testing the substance content of several nutrient parameters in compost, namely Nitrogen (N) by method Destilasi, Phosphorus (P2O5) by method Olsen and Bray, Potassium (K2O) by method Spektrofotometri and Carbon (C)by method Walkey and Black in the laboratory.

Quality of Leaf Litter. Leaf decomposition can release a number of nutrients and materials that can support the productivity of trees and food webs in mangrove ecosystems (Ashton *et al.* 1999). Nutritional value can be defined as a C: N ratio (lower ratio means higher nitrogen concentration and higher nutritional quality) (Ashton *et al.* 1999). The results of the analysis of the highest C: N leaf litter ratio value were obtained from the 2016 reclamation land of 19.02 and the lowest value of the 2014 reclamation land with a value of 13.11 (Table 1). This shows that the reclamation land in 2014 has the highest nutrient value of leaf litter than other lands, although the percentage of N content is lower than the leaf litter on the 2016 reclamation land. This is supported by planting media used for planting teak tree seedlings in the 2014 reclamation land which comes from topsoil. Planting media in the form of topsoil generally have a high nutrient content so that it allows a lot of nutrients to be absorbed by the teak tree and stored on its leaves. The results of the C: N ratio test on these leaves can be used as the basis that leaf litter found in the three reclamation lands can be utilized as a natural fertilizer for the growth of teak trees planted in the area. The low C: N ratio value of leaf litter in reclamation land in 2014 means that it has high nutritional quality and will result in a faster decomposition process. Decomposer microorganisms such as Bacillus and Flavobacterium (Alami *et al.* 2019, Kurniawan *et al.* 2011) will more quickly decompose litter with high nutrient content (Ashton *et al.* 1999, Hanif *et al.* 2015).

Technical Utilization of Leaf Litter as Organic Fertilizer with EM4 and Molasses Bioactivators. The results of making organic fertilizer using the basic ingredients of leaf litter are obtained using the bokashi method (York 2014). The bokashi method is a method that utilizes EM4 (Effective Microorganisms 4) technology. The bokashi method was chosen in this leaf litter composting technique because organic fertilizer fermented using EM4 solution can be used to fertilize the soil and suppress the growth of pathogens in the soil, thereby increasing plant growth and production. In addition, the use of EM4 in the fermentation process will accelerate the decay that occurs compared to the decay process without using additional microorganisms (Khan *et al.* 2009, Winduasari 2012). The results of leaf chopped that have been found are mixed with stems and twigs which cannot be chopped perfectly by a chopper machine. Pieces of these stems will make the fermentation process run long and make the texture of the fertilizer coarser. Therefore it is advisable to sort the leaf litter from the twigs before chopping, so that the results of leaf chopping are pure leaf litter.

Another solid material used in making organic fertilizer is fine bran or bran. Bran or rice bran is waste from the rice milling process. Bran is a good food source for decomposing bacteria in this case is EM4. With high carbohydrate content and vegetable protein, bran is a complete food source for decomposing bacteria. Adding bran to the production of organic fertilizer indirectly has a positive effect on the quality of the compost produced. Thus it can be said that the function and benefits of bran in composting are as a food source for bacteria and as an additional ingredient for producing quality compost. Bran needed is 20 kg (20% of the total 100 kg of fertilizer), temperature reaches more than 50ºC, it is feared that it will kill microorganisms in it so that microorganisms cannot live and carry out their functions.

A good organic fertilizer is fertilizer that prioritizes C-organic content so that it can produce a low C / N ratio value. To achieve the C / N ratio and the content of Nitrogen (N), Phosphorus (P), and Potassium (K) which are in accordance with the standards can be done by microbial fermentation called Effective Microorganism (EM4) (Kurniawan *et al*. 2011).

Other mixtures in making organic fertilizer are animal dung, especially cattle or manure (cow dung that has dried or has been processed). Cow dung has great benefits in making organic fertilizer. The benefits of cow dung include nitrogen (N) content; phosphorus (P); potassium (K); high economic value because it can replace the use of chemical fertilizers so that production costs can be reduced; cow dung is easy to use and is applied as compost for plants; cow dung is able to provide balanced nutrients for the soil; make the soil structure more loose because cow dung will increase the number of microbes in the soil; cow dung can also improve soil pH conditions that are damaged; and by utilizing cow dung as fertilizer turned out to be able to increase crop production to 30%. With the many benefits of cow dung for soil and plants, it is highly recommended adding cow dung in making organic fertilizer. The amount of cow dung prepared is 20 kg (20% of the total 100 kg of fertilizer). Cow dung used should be old cow dung and not cow dung which is still warm (new), this is because the temperature of new cow dung is still high so that it will affect other microorganisms that are added in making organic fertilizer.

The last ingredient used in making organic

fertilizer is husk charcoal. Husk charcoal is generally used as a mixed medium in agriculture. The benefit of using the husk charcoal in making organic fertilizer is that the soil becomes loose so that it improves soil fertility and improves soil structure. In addition, the benefits of using husk charcoal are increasing soil pH thereby increasing the availability of phosphorus (P) and carbon (C). Adding husk charcoal will increase the aeration system in the plant root zone. Husk charcoal can also increase groundwater reserves and increase levels of potassium (K) and magnesium (Mg) exchange. It is generally known that charcoal or charcoal husk has a high silicate (Si) element but is low in Calcium (Ca) content. The silicate element itself has important benefits other than as a functional nutrient that is increasing plant immunity against pests or pathogens found in the soil, drought tolerant and against heavy metals that contaminate the soil. Therefore it is recommended to use husk charcoal as an additional material in making organic fertilizer. The amount of husk charcoal prepared is 20 kg (20% of the total 100 kg of fertilizer). Leaf litter, bran, cow dung and husk charcoal that have been measured according to the dose are mixed into one solid material mixture on a tarpaulin that has been opened on a flat surface. This mixing method is carried out in accordance with the bokashi mixing method by mixing all ingredients into one. Mixing is done by using a shovel.The nitrogen and phosphor contents of this liquid fertilizer (92,000 ppm and 143,000 ppm) were significantly higher ($P<0.05$) than the EM4 (0.07 and 3.22 ppm) (Sastro.*et al* 2013).

After mixing the solid material, a liquid material consisting of EM4 and molasses or molasses is prepared. The EM4 used is EM4 which is sold freely in the market. EM4 is a chocolate solution with a pH of 3.5 - 4.0. EM4 (Effective Microorganisms 4) contains various fermentation microorganisms which are very numerous, approximately 80 genera and these microorganisms can work effectively in the fermentation of organic matter. The four main microorganisms in EM 4 solution are photosynthetic bacteria, *Lactobacillus* sp., *Saccharomyces* sp., and *Actinomycetes* sp. Photosynthetic bacteria (*Rhodopseudomonas* sp.) play a role in forming substances that have benefits for plant secretions, organic matter and harmful gases by using sunlight and earth as energy sources. These substances include amino acids, nucleic acids, bioactive substances and sugars. These substances function to accelerate the growth and development of plants. Besides this microorganisms can increase the growth of other microorganisms that are not pathogenic (Dibia *et al*. 2012, Fisher *et al.* 2000, Isroi *et al*. 2009).

Lactic acid microorganisms (*Lactobasillus* sp.) can produce lactic acid from sugar, can suppress the growth of harmful microorganisms, increase the rate of overhaul of organic materials and can destroy organic materials such as cellulose and lignin, and ferment them without causing adverse effects caused by organic materials that are not biodegradable. *Saccharomyces* sp. or commonly called yeast / yeast functions to form anti-bacterial substances and have benefits for plant growth from amino acids and sugars released by photosynthetic bacteria. It also functions in increasing the number of active cells and root development. *Actinomycetes* sp., *Aspergillus* and *Penicilium* which are included in fermented mushrooms, function in decomposing organic matter quickly to produce alcohol, esters and anti-microbial substances, eliminate odors and can prevent from harmful insects and caterpillars (Aprianis *et al.* 2011, Wahyuni 2016).

EM4 is not harmful to the environment because EM4 culture does not contain microorganisms that are genetically modified. Before use, EM4 needs to be activated first because the microorganisms that are in the EM4 solution are dormant (sleeping). Activation of microorganisms in EM4 can be done by adding water and food which can be molasses or molasses. The amount of EM4 needed in making organic fertilizer with a total amount of fertilizer as much as 100 kg is 100 ml. Molasses known as cane molasses is the last drop of sugar obtained from the sugar crystal separation process which is done 4 times. Four times the separation process aims to find the parent leachate or the last drop of sugar. Molasses is an excellent source of energy for various life forms of microorganisms. Molasses is a source of carbohydrates that stimulate the growth of beneficial microorganisms. A good type of molasses for fertilizer is blackstrap molasses (unsulphered) because it has the highest concentration value of sulfur, potassium, iron and other micronutrients from original sugar cane, so it is not only the sugar content that makes molasses useful, but also the mineral content therein. Molasses is an excellent chelating agent, which means that it can help convert some chemical nutrients into forms that are easily available for microorganisms. The dosage of molasses used in making organic fertilizer with a total amount of 100 kg of fertilizer is 100 ml.

After EM4 and molasses are measured according to size, then mixed into one with the addition of enough water. This solution is a bioactivator solution. The bioactivator solution is then poured into a solid material

Table 1 Result Nutrient content of organic fertilizers according to Indonesian National Standard (SNI)

Chemical properties (%)	Permentan No. 70 Th 2011	Amount according to SNI 19-7030-2004	Organic fertilizer (I) with bioactivator EM4 and molase (1:1) 2 weeks	Organic fertilizer (II) with bioactivator EM4 and molase(1:1) 3 weeks	Quality
C – organik	Min 15	9,8 - 32	37,80	34,89	good
N Total	Min 4	0,40	1,64	1,80	good
Fosfor (P)	Min 4	0,10	0,47	0,42	good
Kalium (K)	Min 4	0,20	0,54	0,48	good
C/N rasio	15-25	10-20	23,05	19,33	good
pH	4-9	6,8 – 7,49	5,5	5	good
Water content	15-25	Max. 50	58,82	59,15	too wet

Table 2 EM4 data formulated with organic ingredients

No.	Composition EM4	The characteristics EM4 that are produced
1.	*Lactobacillus* sp.	Indicator :
2.	*Streptomyces* sp.	Color: Brown
3.	Yeast	Odor : Acid
4.	*Rhodopseudomonas* sp.	Ph : 3.5
5.	*Actinomycetes* sp.	

that has been thoroughly mixed. Stirring is repeated until the water content of the fertilizer is suitable. Water content in suitable fertilizers can be checked by taking a handful of fertilizers and holding it firmly (balled up), if water comes out of fertilizer and fertilizer does not expand then too much water content, but if water does not come out of fertilizer and fertilizer expands slowly slowly and not breaking then the water content is enough on the fertilizer. After all the ingredients are mixed evenly, the tarpaulin on which the fertilizer ingredients are stirred are then tightly closed so that the fermentation can proceed normally. The planned fermentation process is ± 14 days and during the fermentation process the temperature of the fertilizer is maintained not to exceed the temperature of 50ºC. If at the beginning of the fermentation.

Fermentation occurs anaerobically so that a closed space (tarp or gunny sack) is required. At the beginning of fermentation, fertilizer has brownish characteristics with a sweet smell (sugar), but as time goes by fermentation, fertilizer smells acidic and then smells like soil with a blackish color. This character indicates that organic fertilizer with the bokashi method can already be harvested or used. At the beginning of making organic fertilizer, leaf litter is predicted to experience maturity (ready for harvest) at ± 14 days (2 weeks) to ± 21 days (3 weeks) fermentation time. After the fermentation process is carried out for ± 21 days (3 weeks) fertilizer samples are taken to test the nutritional quality. The results of testing the elements on organic fertilizer produced showed in Table 1 and Table 2.

But after observing when the fertilizer is aged ± 21 days (3 weeks), the fertilizer has not matured. It is possible for several things, among others: leaf litter that is used without going through the process of sorting with stems and twigs, so it is possible that the structure of stems and twigs that are classified as large will slow down the fermentation process. In addition, the condition of the leaf litter used is very dry.

This is thought to be the cause of the slow fermentation process. Leaf litter has a high cellulose and lignin content, especially with very dry conditions, so microorganisms will need more time in the decomposition process. Therefore, to accelerate the process of fermentation and decomposition of leaf litter, leaf litter should be used in a wet or rather wet condition so that not all litter is in dry conditions. The size of leaf litter used as raw material for composting must be as small as possible to achieve aeration efficiency and to be more easily digested or broken down by microorganisms. The smaller the particles, the more the surface area of litter that is in contact with microorganisms, so that microorganisms can digest and decompose litter in a shorter time.

As conclusion, the study of the use of leaf litter in the reclaimed land of former limestone mining in the area of PT. Semen Gresik - Semen Indonesia persero (Tbk) : Leaf litter found in the reclaimed land of the former limestone quarry located in PT. Semen Gresik - Semen Indonesia Persero (Tbk) can be utilized by processing it into organic fertilizer. The processing of

organic waste into organic fertilizer was successfully carried out by the bokhasi method of composition of solid material in the form of leaf litter, bran, cow dung and husk charcoal with a ratio of 2: 1: 1: 1 and the search material in the form of EM4 and molase with a dose of 100 mL per each 100kg (1:1) in 3 weeks of solid material dissolved in enough water (fertilizer can be clenched and expand slowly and not break) with the characteristics of the microbial composition of *Lactobacillus* sp, *Streptomyces* sp, Yeast, *Rhodopseudomonas* sp, *Actinomycetes* sp with brown EM4 color indicator, sour smell, pH 3.5, and the most nutrient content is organic C.

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