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Technical Paper

Sieving Effect of Sorting Machine with Vibration Table Type on Cacao Pod Based Compost

Pengaruh Sudut Kemiringan Ayakan pada Mesin Sortasi Tipe Meja untuk Kompos Pod Kakao

Siswoyo Soekarno[1], Edy Suharyanto[1] dan Ahmad Hudi Arif[1]

Abstract

Cacao pod is the biggest part (70% of weight) of Cacao, which was not optimaly utilized.Cacao pod is one of organic material that can be functioned as an organic fertilizer, such as compost. When utilized with right proportion, organic fertilizer is safe for plants and not degrades the soil composition. Composting process is one of utilization form of Cacao pod. The size reduction of cacao pod in the organic fertilizer process would help to accelerate the composting process. Smaller particle size would faster interacting with environment, so the composting process would be well accelerated if compared to the material with bigger size. Chopping machine of Cacao pod is used to cut the biomass to be small particle in order to be able to be utilized as some important necessity, i.e. fertilizer or farm animals feed. However, Varies compost size was one of the problems faced in the composting process. Therefore, the sorting process was needed to be done after chopping process, so the compost size became uniform and fulfill the user demand. This research was aimed at knowing the slope effect of sorting machine and rotation speed (RPM). The method used in analyzing the results of this research was comparing the treatment factors, which are shown with histogram. As the super small size of compost recommended for applying in the fertilizing process, so the optimum treatment combination for having high mass fraction of SS compost grade was achieved at 12^o slope of sieve table and 1400 RPM motor rotation speed. As bigger the particle densities of the compost size as smaller the compost porosity. Mass loss was very low at all treatment combination with the value around 0.43-1.33%, so the sieving efficiency can be said very high.

Keywords : vibration table type, slope of sieve table, motor speed rotation (RPM)

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INTRODUCTION

Indonesia is the biggest and third biggest producer of cacao in the Asian and world country, respectively. In 2002, cacao plantation had provided job opportunity for more or less 900 thousands farmers, who live in eastern part of Indonesia and gave the third highest exchange contribution of plantation sub-sector after rubber and oil palm tree plantation with the value of US$ 701 million (Bako Baon, 2005).

The biggest component of cacao is the pod, which consist of 70% of cacao fruit. Mostly apart of fruit have potency to be utilized as source of organic fertilizer, including cacao. Organic fertilizer is more environment friendly and not danger for health when utilized. Recently, utilization of cacao pod (Fig.1) as organic fertilizer as known as compost is very minimum in which they are directly put on the soil under the cacao trees with the expectation to become organic fertilizer for those cacao plants after some time or used as farmer's animal feed. Composting process based on cacao pod is one of efforts held for improving the added value of cacao pod, which were not utilized well during this time (Mulato, et al., 2005; Mulato and Sukrisno, 2006).

In the composting process of cacao pod, the particle size of cacao pod in the market demand need the small and uniform size of less than or equal 4 mesh. The size reduction of cacao pod in the organic fertilizer process would help to accelerate the composting process. Smaller particle size would faster interacting with environment, so the composting process would be well accelerated if compared to the material with bigger size (Soekarno et al., 2007).

To have the small size and uniform compost produced, it is needed the sieving machine, which able to separate the material based on the material size fraction. One of the machines can be used

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for sieving compost based cacao pod material is vibration table type of sorting machine consisting of three sieving level.

The objective of this research was to know the effect of sorting machine slope on the mean weight diameter of compost sieved with the treatment of several speed rotation of motor (RPM).

Cacao plant (Fig. 2) (*Theobroma cacao* L) includes in the family of *Sterculiaceae*, which came from Mexico, Latin America. Due to its nutrient content, taste, and high merit, cacao plant spread out of the world very fast, mainly in the equator region (Nasution, 1985 in Trianawati, 1996).

Organic fertilizer is an end product and or product among differentiating impact and plant and animal residue, for example: residue of copra after extracting oil, etc. (Sutanto, 2002). Organic fertilizer is produced of organic material containing several kinds of substance, so this fertilizer contains almost all substances, either macro or micro. In the other side, the availability of substances needed in organic fertilizer usually just in small amount. Table 1 presents the comparison of organic and inorganic fertilizer. Chemical composition of compost varies depending on raw material, which are used for organic fertilizer. Table 2 shows the chemical composition of compost made of cacao pod.

Beside chopping or crushing, composting also has to be considered in the process of producing organic fertilizer. Composting process can be done with several methods, for instance: adding micro organism or other substances, which capable to accelerate the composting process. Natural composting would happen in longer time if compared with the existence of additional substances; even it can spend 12 months. To accelerate the composting process of organic material, it can be used some activator viz. *Organic Decomposer (OrgaDec) and Starbio Decomposer (StarDec)* (Crawford, 2003; Yuwono, 2005).

Sorting or grading is separation of material by sieving in order to have several size of particle. This process is held to produce the particle mixed with certain size for fulfill market demand (Lienda, 1995). Henderson and Perry (1976) stated that sorting was more objected to separate material, which clean from contaminant to be various of quality based on size, shape, particle density, texture, and color.

Materials and Methods

Material and Apparatus

Material used in this experiment was compost based cacao pod resulted from the chopping process of cacao fruit. Apparatus used in this experiment were: (1) sieving (sorting machine) of vibration table type (Figure 3); (2) tachometer; (3)

Figure 1. Cacao pod material

Figure 2. Cacao plant (*Theobroma cacao* L)

Table 1. Comparison of organic and inorganic fertilizer

No	Compost (organic fertilizer)	Inorganic fertilizer
1.	Containing complete macro and micro substances, but in small amount	Containing only some substances, but in a big amount
2.	Loosen the Soil structure and left the organic material	Unable to repair the soil structure, could effect the soil hardening in long time utilization
3.	Cheap price	Expensive price
4.	Increasing the absorption power of soil	Unable to increase the absorption power of soil
5.	Reconstructing the organism living in the soil	Unable to reconstruct the organism living in the soil
6.	Easy to be produced	Produced only by industry or fabric

scales; (4) container; (5) measuring glass; (6) Oven; and (7) stop watch. Sieving/sorting machine was the main apparatus used in this activity. The machine consist of three levels of sieve table, which in the top level was the sieve with diameter of 7.5 mm and material not sieved in this level was called as large size; the middle level was the sieve with 6.5 mm diameter and material not sieved in this level was called as the medium size; the lower sieve has 5.5 mm of diameter and material not sieved in this level was called as small size, while material sieved in this level was called as super small size.

Analysis Method

The results of this research were analyzed by comparing the treatment factors, which are shown with histogram. The treatment factors were divided into two levels as follows.

1. **S** factor, which consist of three levels: S_1, S_2, S_3 for sieve table slope of 12^O, 15^O, and 18^O, respectively.
2. **R** factor, which consist of three levels: R_1, R_2, and R_3 for motor Rotation speed of 1400, 1600, and 1800 RPM, respectively.
3. Treatment combination of S and R factors were as follows:
   S_1R_1; S_1R_2; S_1R_3;
   S_2R_1; S_2R_2; S_2R_3;
   S_3R_1; S_3R_2; S_3R_3.

Parameters measured in this research were Mass fraction of compost on each sieve level, compost porosity on each sieve level, particle density, and mass loss.

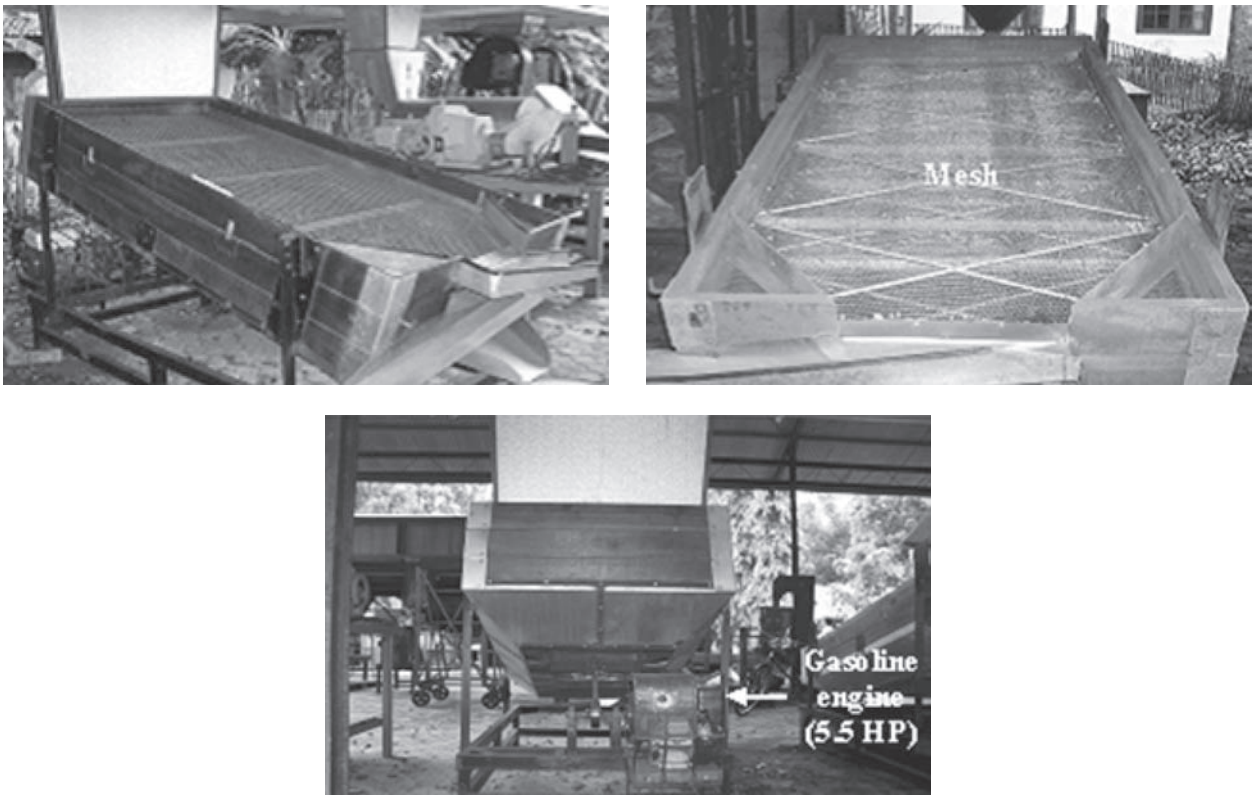


Figure 3. Sieving/sorting machine with vibration table type; (a) side view, (b) top view, and (c) back view

Results and Discussion

Sieving process was aimed at sorting or grading the compost material after chopping to be for grade levels, viz. Large (L), Medium (M), Small (S), and Super Small (SS) size. In this research activity, the result of sieving process can be seen in Figure 4.

Mass Fraction

Figure 5 shows the graphic of material Mass fraction resulted on sieving machine process.

Based on the treatment of sieve table slope as in the Fig. 5, the biggest mass fractions with level of super small size were achieved at 12^o of sieve table slope for all motor rotation speed levels with average of 65.7%. This result indicated that at slightly slope of sieve table, the compost would be sieved longer time than steep slope, so the size separating process of compost fraction was perfectly conducted. This result inline with Soekarno et al. (2007) and Mulato et al. (2005) statements that as smaller as mass fraction of compost, the fertilizing process would be better due to faster interacting process with the environment. While, at all sieve table slope treatment, it was resulted that as higher the motor rotation speed, as smaller the mass fraction of super small size (SS) compost, but the mass fraction of large size (L) compost tended to increase. High motor rotation speed caused the vibration of sieve table bigger and sieving process becoming faster, as well. Big vibration possibly caused particle size, which should be sieved to be smaller particle could not well sort since too fast leaving the sieve table to container. This result indicates that the treatment combination affected to the Mass fraction of compost sieved using the vibration table type of sieving/sorting machine.

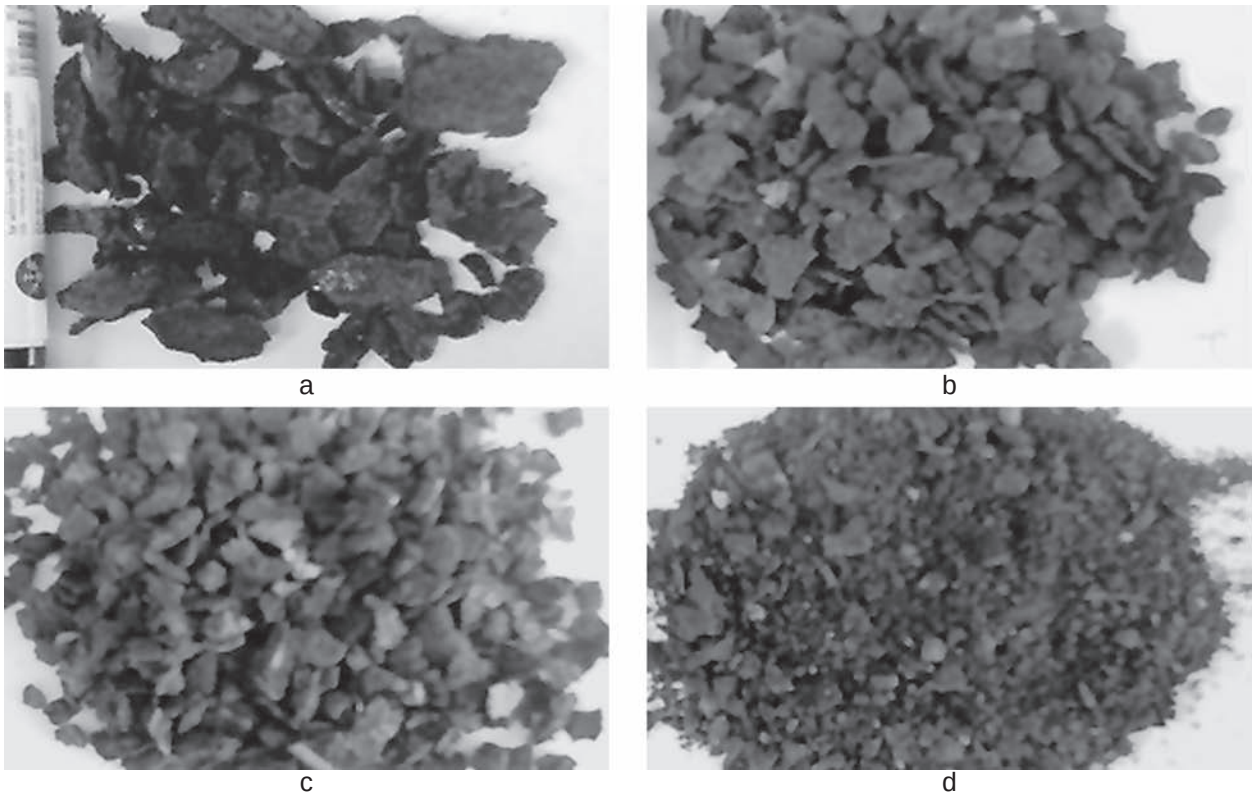
Table 2. Chemical composition of organic material of cacao pod

No	Chemical contents	Content portion
1	pH	5.40
2	N (%)	1.30
3	C (%)	33.71
4	C/N	26.00
5	P2O5 (%)	0.19
6	K2O (%)	5.50
7	CaO (%)	0.23
8	MgO	0.59
9	Cu (ppm)	-
10	Zn (ppm)	-

(*source*: Hety, 2005)

Particle Density of Mass Fraction Resulted From Sieving Process

Density is the comparison of mass material with its volume. Measurement of density in this research was held using measuring glass of 1000 ml. Fig. 6 shows the result of particle density fro every treatment combination of sieving table slope and motor rotation speed (RPM).



a b c d

Figure 4. Sieving process result of compost based cacao pod at all grade level (Note: a = L grade size; b = M grade size; c = S grade size; d = SS grade size)

Based on Fig. 6, it can be seen that at all combination treatments, the particle density of compost with super small size achieved the highest value compared the other combination with average density of 0.45 g/ml, except for combination S_3R_2, in which the highest particle density showed by the compost with small size. This indicates that as bigger the compost size, as smaller the particle density. This was happening because the same kind of material with bigger size, the density would be smaller when put in the same container. While small size material would place in the container with few porosity, so the density would be higher.

Porosity of Mass Fraction Resulted From Sieving Process

Porosity states the empty volume of compost material in a container and in percentage unit. Porosity measurement was done using measure glass of 1000 ml by putting the compost material with certain grade size and adding water into the glass until reach the 1000 ml level. The water volume added into the glass divided by 1000 ml and multiplied with 100% was the porosity of compost. Fig. 7 shows result of porosity measurement of compost at all mass fraction size produced during sieving process for all treatments.

Based on Fig. 7, it can be seen that the compost with larger size had the biggest porosity among the other size, while on the other hand, the super small size of compost had the lowest porosity. This indicates that as lower the grade size of compost as more compact the compost resulted for further interaction with soil during fertilizing process. This statement inline with Mulato et al. (2005) and Soekarno et al. (2007 statements that as smaller as Mass fraction porosity of compost, the fertilizing process would be better due to faster interacting process with the environment.

Mass Loss

Mass loss is the mass or weight losses of compost material during sorting/sieving process. The measurement process was held by sampling the 100 kg compost material will be sieved as initial mass (M_0), the sieving was processed. After that, the mass of compost sieved at all sieve level (L, M, S, and SS) was summed and called Mass out (M_{out}). The result of ratio between (M_0-M_{out}) and M_0, then multiplied with 100% was the mass loss. Mass loss resulted during sieving process in this research is shown in Fig. 8.

From Fig. 8, it can be indicated that the mass loss due to sieving process was around 0.43-1.33 Kg or in other word, the percentage of compost sieved during sieving process was around 98.67 – 99.67%. It is therefore, the sieving efficiency was very high. The low mass loss was happened at treatment combination of small degree of sieve table slope and low motor rotation speed. At

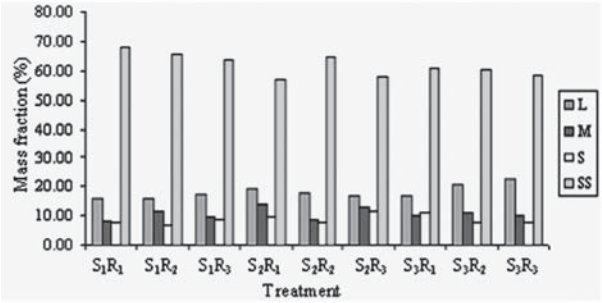


Figure 5. Mass fraction histogram of compost sieved on each sieve level and all treatments (Notes: L : Large size compost; M : Medium size compost; S : Small size compost; SS : Super small size compost)

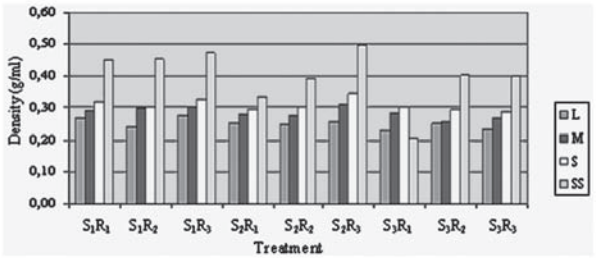


Figure 6. Particle density histogram of compost based cacao pod sieved on vibration table type of sorting machine at every treatment combination (Notes: L: Large size compost; M: Medium size compost; S: Small size compost; SS: Super small size compost)

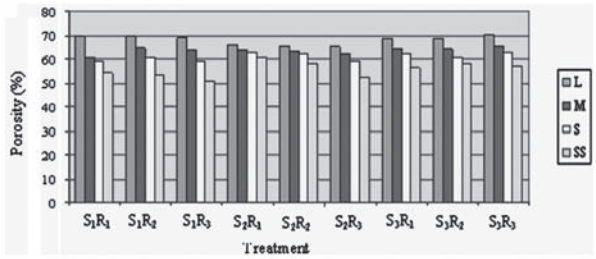


Figure 7. Mass fraction porosity histogram of sieving process results at all treatments (Notes: L : Large size compost; M : Medium size compost; S : Small size compost; SS : Super small size compost)

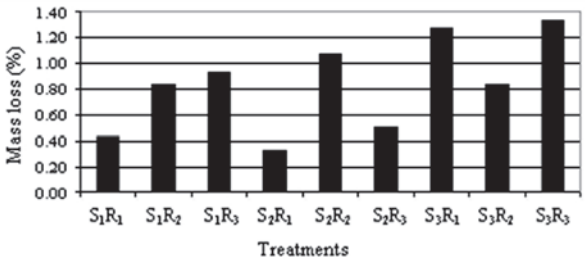


Figure 8. Mass loss histogram at every treatment during sieving process

treatment combination of high degree of sieve table slope and high motor rotation speed, the mass loss tended to high. This was happened because some of the compost sieved were not exactly enter to the sack or container provided at the machine outlet. Besides, the cause of mass loss could be due to material cleaning process by operator after sieving process, for instance: throwing out stone material; waste, which was not compost material as like plastic, tree branches, leaves, etc.

Conclusions

Based on the overall parameter observed in this research, it can be concluded that the sieving effect of compost based cacao pod using vibration table type of sieving/sorting machine were as follows:

1. As the super small size of compost recommended for applying in the fertilizing process, so the optimum treatment combination for having high mass fraction of SS compost grade was achieved at 12^{o} slope of sieve table and 1400 RPM motor rotation speed.
2. As bigger the particle density as smaller the compost porosity.
3. Mass loss was very low at all treatment combinations with the value around 0.43-1.33%, so the sieving efficiency can be said very high.

As the super small size of compost recommended for applying in the fertilizing process, so the compost material, which still have large, medium, and small size are recommended to be further processed by grinding in order to be able to be sieved with 5.5 mm sieve diameter.

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