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LITTER CHARACTERISTICS OF DOMINANT TREES AT THE MAIN CAMPUS OF SEBELAS MARET UNIVERSITY AS A POTENTIAL SOURCE OF COMPOST PRODUCTION

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ABSTRACT: Green Campus Program as responses to the problem of global climate change has become a major concern in the world. Availability of green open space with tree community is a demand for healthy environment. However, it produces organic waste in the form of litter that requires treatment to use as potential materials for compost production. The identification, quantification and characterization of organic waste biomass was conducted to measure the quality and quantity of potential materials contained for compost . The results showed that the production of waste from main campus of Sebelas Maret University at Kentingan was around 400 - 1000 kg per day, 88.1% of which was organic waste which potentially can be used for compost production. Average nutrient content of the litters for 10 dominant tree species is quite high (Nitrogen: 1.26 to 3.36%, P_2O_5: 0.41 to 1.28%, K_2O: 0.65 to 3.19; 40.58 to 54.33% of organic C and the ratio C/N 20-40). High nutrient contents fertilizer elements supporting its potential as compost material, whereas the C-organic is important for biogas production. However, for use in the manufacture of compost should pursue in the right combination and in integrative way.

Keywords: biogas, green campus, compost, green open spaces, litter.

INTRODUCTION

The phenomenon of global warming has become a major issue around the world today. Cities as the center of human civilization are facing the greatest impact due to changes in the environment leading to the phenomenon of ecological suicide. Floods, water crisis, environmental illness, environmental pollution and varieties of socio-environmental problems of heavy burden on general urban developments (OECD, 2010; Joga and Ismaun, 2011). The threat of global warming lately implications for the improvement of people's needs, especially in urban areas and the existence of the urban forest (Syamsurijal, 2008; OECD, 2010). Therefore it is necessary to move the city toward the accelerated development of green cities, most are not able to offset the accelerating degradation of the environment. Land remaining forest is directed to build the city. Urban forest is an approach and the application of one or more functions in groups of forest vegetation in urban areas to achieve the purpose of protection, recreation, aesthetics, and other utility functions for the benefit of urban communities (Sundari, 2007; OECD, 2010). Urban forest is very important for reducing the CO_2 content through fixation by vegetation and meeting the needs of O_2 for respiration, especially to humans (OECD, 2010; Septriana et al., 2012).

Sebelas Maret University campus at Kentingan with an area of approximately 60 hectares is potentially utilized for the construction of part of the Solo city forests. Utilization as a campus conservation is a great hope that the land could double the solution of environmental problems as well as a vehicle for education (Sugiyarto, 2011). Passion to build a green campus lately also supports for the evaluation and for the realization of beautiful, comfortable and high-value education campus. Sugiyarto (2012) showed that the UNS Campus at Kentingan area Surakarta is very potential to be developed as an integrated conservation campus. Its vegetation is composed of groups of trees, shrubs and herbaceous and comprises 151 species identified from 8577 individual trees with diversity index value of 0.94. The dominant tree species are Angsana (*Pterocarpus indicus*) with INP 0.363, acacia (*Senegalia pseudonigrescens*) with INP 0.093 and (*Tectona grandis*) with INP 0.069. These three dominant tree species and other species yield a large number of litters of potential biomass, so far not utilized properly. In addition the campus with more than 10,000 active students, plus academic and none academic staffs, daily activities produces other organic wastes especially paper and food waste, causing environmental problems including the potential for disease transmission, disrupt the aesthetic and cause odor pollution, those encouraging the needs for proper treatment and beneficial use of the waste (Sugiyarto, 2012).

The success of the use of organic waste for biogas and compost depends on the quality of organic matter available. Both of these processes in principle are process of decomposition of organic matter which depends on the characteristics of organic matter, decomposers organisms and chemical-physical environmental conditions (CWMI, 2004/2007; FAO 56; Toren, 2014). Comparison of C/N ratio, largely determines the mineralization or immobilization of nitrogen in the cells of microorganisms (Windusari et al., 2012). Speed on the rate of decomposition of leaf litter quality depends on the ratio of C/N, lignin and polyphenol contents. Leaf litter can be said to be of high quality if the C/N ratio less than 25, the lignin contents less than 15% and the polyphenols contents less than 3%, so its rapid weathering (Hairiah et al., 2000). On the other hand a wide variety of organic waste biomasses are potential to be used for processing into alternative fuels such as biogas through anaerobic bio-digester technology (Inpurwanto, 2012). Processing of organic waste into biogas has a lot advantage including; reducing the greenhouse effect, reduces odors, prevent the spread of disease and to produce byproducts such as solid and liquid organic fertilizer (Haryati, 2006). The use of technology and proper techniques for mixing organic matter digestion to produce optimal product are of essential requirements (Sriwahyono et al., 2011; Alex, 2012).

The quality of organic fertilizers depends on the quality of raw materials such as organic waste. The diversity of sources of organic matter also determine compliance with the cultivation of plants. Test for the suitability of fertilizer products with various test plants are indispensable. The identification, quantification and characterization of organic waste biomass was conducted to measure the quality and quantity of potential materials contained for compost and biogas.

METHOD AND MATERIALS

The study was conducted in July 2013 - November 2013 in the UNS campus area at Kentingan, Laboratory of Biology, Faculty of Science, Faculty of Agriculture and soil chemistry laboratory of UNS Surakarta.

PROCEDURES

Quantification and classification of waste

First waste collection was done 3 times with the help of the janitor in a way that accommodated all the waste that could be disposed of in landfills (TPA) with large plastic bags. Secondly the collected waste was brought to the shelter, 10 bags were randomly selected for sorting and classified into organic waste (wet and dry), paper, plastic and other forms (metal, glass, etc.). Lastly at this step the sorted and classified litters were weighted and stored for next step involved laboratory.

Characterization of waste

Using purposive random sampling four (4) points each were specified (i.e. in places dominated by the 10 most dominant tree species) including; Angsana, Acacia, Acid Londo, Banyan, Sunshade Umbrella, Teak, Netherlands teaks, Flamboyan, Mahogany and Pulai (Sugiyarto, 2012). In the morning installed 1 x 1 m^2 litter traps under the canopy area of a sample community and left for 24 hours. The collected catch were sorted, classified and stored for later characterization in laboratory including; litter size of the litter material, specific leaf morphological characteristics, nutrient content of C, N, P, K, Fe, Cu, Zn, Ca and Mg).

Data analysis

The research data presented and analyzed by partial quantitative descriptive then displayed for comparison as quality organic ingredients used in Indonesian National Standard (SNI) No. 19-7030-2004 about specs domestic compost from organic waste.

RESULTS AND DISCUSSION

A. RESULTS

Diversity and Quantity of Waste

Based on the results of the entire waste collection in the UNS campus at Kentingan by janitor as can be seen in (table 1) that, there is a striking difference in the total weight of waste at different times. The total waste generated daily ranges from 400 to 1000 kg, at the time of observation an increase in the weight of the garbage that is 419 kg in August to 632 kg and 926 kg in September. This is due to the increase in number of academic activities and organic waste (88.1%) followed by plastic (7.6%), paper (3.6%) and other inorganic materials (0.7%) wastes. In totality, potential production of organic waste ranges from 300 to 900 kg per day. This shows great potential of biomass waste for further use, especially as materials for biogas and organic fertilizer. In addition there is potential for waste papers recycling process. Fortunately in general, plastics and paper wastes have been utilized by janitors for selling to collectors in an effort to raise their income. Still there are high components of plastics and inorganic waste (8.3%) which become by its own potential problems.

Table (1): The average weight of dry waste (kg) collected per day

Time of garbage collection	Plastic (kg)	Paper (kg)	Organic (kg)	Others (kg)	Total (kg)
1 August 30, 2013	45.90	22.95	346.12	4.76	419.70
2 Sept. 13 2013	54.20	23.44	555.10	4.00	636.74
3. Sept, 27 2013	50.22	25.20	845.50	5.40	926.32
Average	50.11	23.86	582.24	4.72	660.92
Percentage (%)	7.6	3.6	88.1	0.7	100

The Quality of Waste in UNS Campus at Kentingan

Based on the results of sampling leaf litters of 10 tree species most dominant in UNS college at Kentingan obtained information can be interpreted that;

Not all types of trees produces large quantities of leaf litters continuously, but periodically shedding their leaves. Tree species with such types includes; *Tectona grandis*, *Swietenia mahogoni*, *Alstonia scholaris* and *Pterocarpus indicus*. This affects the ease of the litter sample collection. Furthermore, if it is associated with the utilization plan in composting and biogas production, are expected to affect the quality and quantity of produced products.

Size of leaf litters for 10 dominant tree species in campus is very diverse (Table 2), from of small size such as *Delonix regia* and *Guazumma ulmifolia* to large, e.g. *Tectona grandis* and Netherland teak identity. For species with small lamina size, i.e. *Pithecellobium dulce* and *Delonix regia* its collection pretty hard so it must rely on trapping techniques. The smaller size and the thin lamina, the more support for the speed of the decomposition process. In contrast to large-sized leaf lamina requires the enumeration process, for use in composting and biogas production. The existence trichome generally helps speed up the decomposition process.

Table 2. Visual character of the leaf lamina for 10 dominant tree species at UNS main campus

No.	Tree type	Average (length x width) of the lamina (cm)	visual morphological characters of leaves / litter
1	*Pterocarpus indicus*	10.50 x 5.67	single pinnate compound leaves, thin, shiny, slippery
2	*Senegalia pseudonigrescens*	10.75 x 2.75	Single leaf, thick, shiny, slippery
3	*Pithecellobium dulce*	2.76 x 1.25	compound forked leaves, thick, pale, coarse
4	*Ficus benjamina*	7.00 x 3.67	Single leaf, thick, shiny, slippery
5	*Filicium decipiens*	19.50 x 1.90	Single compound leaves, thick, shiny, slippery
6	*Tectona grandis*	43.50 x 26.70	Single leaf, thin, coarse, pale, many trichome
7	*Guazuma ulmifolia*	16.00 x 11.80	Single leaf, thin, coarse, shiny, many trichomes at the bottom
8	*Delonix regia*	1.00 x 0.37	Double compound leaves, thin, smooth, pale
9	*Swietenia mahagoni*	19.00 x 8.00	Compound pinnate leaves, thin, shiny, slippery
10	*Alstonia scholaris*	16.50 x 5.57	Single leaf rosette arrangement, thick, shiny, slippery

Table 3 Nutrient Content / main nutrient of leaf litter organic waste for dominant tree species at UNS campus

No.	Tree type	N (%)	P_2O_5 (%)	K_2O (%)	Organic Comp. (%)	Ratio C/N
1	*Pterocarpus indicus*	3.36	1.18	3.19	40.58	12.08
2	*Senegalia pseudonigrescens*	2.31	0.42	0.85	50. 00	21.65
3	*Pithecellobium dulce*	2.17	0.50	0.92	45.77	21.09
4	*Ficus benjamina*	1.26	0.98	4.11	49.13	39.00
5	*Filicium decipiens*	1.69	0.41	0.95	53.75	31.80
6	*Tectona grandis*	1.62	0.92	1.30	54.81	33.83
7	*Guazuma ulmifolia*	1.93	0.95	1.94	51.06	26.45
8	*Delonix regia*	1.65	1.28	0.65	43.56	26.40
9	*Swietenia mahagoni*	1.26	0.59	1.32	49.42	39.22
10	*Alstonia scholaris*	1.82	0.88	1.62	54.33	29.85

B. DISCUSION

Fertilizer is one of the sources of artificial nutrients needed to overcome the multiple nutritional deficiencies, especially the nitrogen (N), phosphorus (P), and potassium (K) elements, whereas elemental sulfur, calcium, magnesium, iron, copper, zinc, and boron are elements that are needed in small amounts (micronutrients). Based on origin, fertilizers can be classified into two types; organic and inorganic fertilizers. Organic fertilizer is a fertilizer that is derived from all the rest of the plant material, green manure, and the manure (has low) nutrient content. Inorganic fertilizers are fertilizers that deliberately made by humans in the factory and contain certain nutrients in high concentrations.

The excellence of organic fertilizer when compared to inorganic fertilizers is that its functionality can support to improve the physical, chemical and biological soil fertility while it can functions in the long term (CWMI, 2004/2007; FAO 56; Sri Wahyono et al., 2011). Organic fertilizers are available in various forms, such as: green manure, manure, compost, liquid fertilizer and biological fertilizer. The third last form (compost) is now preferred because it is easy in application and packed well so it can be widely traded. Compost is an organic fertilizer made by the decaying plant debris as the result of an overhaul of organic matter by microbes with the end result in the form of compost that has a low ratio of C/N. Ideal material for composting has the C/N ratio of about 30, while the resulting compost has a ratio of C/N < 20. Organic materials which have the C/N ratio much higher above 30 will be flattened in a long time, otherwise if the ratio is too low there will be loss of N due to evaporation during the reform process underway (CWMI, 2004/2007; FAO 56; Toren, 2014).

The basic ingredient of compost typically contains 15-60% cellulose, 10-30% hemicellulose, 5-30% lignin, 5-40% protein, 3-5% mineral matter (ash). In addition to starch, 2-30% material contained (sugars, amino acids, urea, ammonium salts), are soluble in hot and cold water and 1-15% fat oils and waxes are soluble in ethers and alcohols. The processes of decomposition for organic components take place under mesophilic and thermophilic conditions. Pile composting method on the soil surface, soil pits, or indoor produces humus dark material after 3 – 4 months and is a source of organic matter that maintain the high and healthy level for soil life thus enabled for sustainable agriculture (Sutanto, 2002; CWMI, 2004/2007; FAO 56; Toren, 2014).

Composting is an attempt essentially to turn the microbial activity to be able to speed up the process of decomposition of organic matter. Here Microbes in question, among other things are; bacteria, fungi, microorganisms and so on, while organic matter are the raw materials for composting, such as straw, agricultural waste, animal waste /animal etc. The way to make various types of compost depends on; state of the manufacturing areas, the culture, the desired quality, the amount of compost needed, kinds of materials available and taste-makers (Fauzi, 2004; CWMI, 2004/2007; FAO 56; Toren, 2014).

Composting is intended to reduce levels of carbon to nitrogen often called the C/N ratio. Compost that its basic raw material or levels of C/N is still high is not good for plants and soil. Crops or households residues that have not been composted when administered directly into the ground the compositing process will occur in the soil. Therefore, if enough the water content and the air in the soil readily available then the composting process is rapid and resulting in soil CO_2 levels also increased rapidly (FAO 56; Toren 2014). This condition is not favorable for the soil and plants on it. When this process occurs on light soils, it can cause the water holding capacity of the soil to decreases, coarse soil structure changed as similar for fibrous. The chemical standard test used to measure the levels of C/N ratio ranges from 10-30 for mature compost (Marsono and Sigit, 200; CWMI, 2004/2007; FAO 56).

Compost will improve soil fertility and stimulates healthy root. Compost improves soil structure by increasing soil organic matter content and will increase the ability of soil to maintain soil water content. Activity of soil microbes that are beneficial to plants will increase with the addition of compost. Microbial activity helps the plants to absorb nutrients from the soil and produce compounds that can stimulate plant growth. Soil microbial activity is also known to help plants against attacks from disease (Isroi, 2007; CWMI, 2004/2007; FAO 56; Toren 2014).

CONCLUSION

Total waste production in UNS main campus range from 400-1000 kg per day .The major campus waste consists of organic waste (88.1%) from tree fallen leaves in which the amount depends on the season. Content of macro and micro nutrients from leaf litter contributed by 10 dominant tree species in UNS main campus at Kentingan is high enough and C / N ratio values around 20-30, so potentially is good for compost production.

Recommendation

Litters generated in campus can be used for compost production for academic and commercial purposes; and feasibility studies on the economic potential for compost production in the campus are recommended. In addition, further study is needed to evaluate the potential for establishment of the recycling process of the paper and plastic waste generation.

REFERENCES

1. B. Zaman and S. Endro, Effect of Mixing SampahDomestik Studies, Rice Bran, and Dregs Cane with Mac DonaldTerhadap Maturity Method Precipitation Kompos.Jurnal 2 (1): 89-94, 2007.
2. Cornell Waste Management Institute (CWMI), Compost Fact Sheet Series; Improving and Maintaining Compost Quality, 2004/2007. These fact sheets can be accessed at: http://cwmi.css.cornell.edu/factsheets.htm
3. D. Septriana, A. Indrawan, E.N. Dahlan, and N. Suratijaya. Predictions based oxygen oxygen demand in the city of Padang, West Sumatra. Journal of Tropical Forest Management X (2): 47-57, 2004.
4. E.B. Walujo, Human Involvement and Biodiversity Conservation in Botanic Garden Indonesia.The Bulletin14 (1): 1-7, 2011
5. E. Kusratmoko, D. Sukanta, M.P. Tambunan, and Sobirin. 2002 city forest hydrology studies the University of Indonesia, Depok. MAKARA SCIENCE. 6 (1): 7-14, 2011.
6. E.S. Sundari, Study to Determine Urban Forest Function in Urban Environmental Problems (Indonesian). Journal of Urban and Regional Planning 7 (2): 1- 16, 2007.
7. E. Toren, Feasibility of and Suggested Methods for Operating a Compost Facility at the UBC Farm, UBC Social Ecological Economic Development Studies (SEEDS) Student Report; University of British Columbia APBI 497 January 14, 2014.
8. FAO, Soil management: compost production and use in tropical and subtropical environments. Soil Bulletin (56). FAO UN, Rome, 1987.
9. G.S. Senesil, M. Dell' Aglio, A. De Giacomo, O.De Pascale, Z. Al Chami, T.M. Miano and C. Zaccone , Elemental Composition Analysis of Plants and Composts Used for Soil Remediation by Laser-Induced Breakdown Spectroscopy. Volume 42, Issue 6, pages 791–798, 2014.
10. I. K. Knabner, The macromolecular organic composition of plant and microbial residues as inputs to soil organic matter. Soil Biology and Biochemistry. Vol 34: 139-162, 2002.
11. Inpurwanto, Production of biogas from waste chicken farm with the addition of organic load and hydraulic residence time in the anaerobic biodigester system is continuous. THESIS. Graduate Program UNS, Surakarta, 2007.
12. McKenzie RH. 1992. Alberta Agriculture, Food and Rural Development: Micronutrient Requirements of Crops.
13. M. Indrawan, R. B. Primack, and J. Suprijatna, Conservation Biology. Torch Foundation Indonesia - Conservation International - Indonesia - PILI - WWF Indonesia - EU - YABSSHI. Jakarta, 2007.
14. Misra RV and Roy RN. 2002. On-Farm Composting Methods: FAO, Rome
15. M.J. Depaz,, Composting – Waste Alternatives. University of Florida Soil and Water Science Department, 2010.
16. N. Joga and I. Ismaun, RTH 30%; Green City Resolution, .PT Scholastic Press, Jakarta.
17. Organisation for Economic Co-operation and Development (OECD); Cities and Green Growth, 3rd Annual Meeting of the OECD Urban Roundtable of Mayors and Ministers, OECD Conference Centre, Paris, 25 May 2010.
18. P. Barak, Essential Elements for Plant Growth; Macronutrients and Micronutrients, 1999.
19. R.P. Tamin, Nursanti and Albayudi. Type Identification and Propagation Local Endomicrorhiza Forest Research Campus Unviversity of Jambi.Journal of Edinburgh University Science Series 14 (1): 23-28. 2012.

20. S. Wahjono, F.L. Sahwan, and F. Suryanto, Make organic fertilizer granules of various wastes. AgroMedia, Jakarta, 2011.
21. Sugiyarto, Study of Biological Diversity on Campus UNS Kentingan as Basic Conservation Campus Development; I. Structure and Vegetation Composition. Laporan Professor Research Grant. Department of Biological Science UNS, Surakarta, 2012.
22. Sugiyarto, Biodiversity conservation based on local wisdom (Java). Inauguration Speech Sciences Conservation Biology Faculty UNS Surakarta, 2011.
23. T.W. Widodo, Biogas for household electrical generator. News Journal of Agricultural Research and Development 29 (2): 3-10, 2008