PRODUCTION OF BIOCHAR FROM COCOA POD HUSK: PRELIMINARY RESULT

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ABSTRACT – *Biochar, a high carbon compound made from pyrolysis process of biomass has recently created an interest in many agriculturists. And therefore, currently, there are many studies that have been carried out on the importance of biochar to plant growth. Among the materials that can be used to make biochar is cocoa pod husk (CPH). Normally, CPH is only categorized as a waste from cocoa since it has been neglected in cocoa field by the farmers. A mound of CPH in field can be a good habitat for pests and diseases especially if the CPH is already infected with pest and disease such as cocoa pod borer and Phythopthora palmivora, respectively. However, CPH can be recycled to cocoa farm by changing it to more valuable products such as into compost and biochar. Therefore, this study was conducted to produce biochar from CPH and determine the value that can be contributed by the cocoa pod husk biochar. This biochar was prepared using a simple and affordable method, so that, it can be used by the cocoa farmers later on. The process of making biochar from CPH using simple technique was documented including its duration of burning process, quantity produced in each production etc. Nutrient content in CPH biochar was also analysed. Preliminary results of the analysis indicated that biochar from cocoa pod husk were rich in nitrogen and potassium.*

Key words: Biochar, cocoa pod husk, pyrolysis, nutrient recycling, waste management

INTRODUCTION

Biochar, a high carbon compound made from pyrolysis process of biomass has recently created an interest in many agriculturists. And therefore, currently, there are many studies that have been carried out on the importance of biochar to plant growth. They found that biochar can improve soil quality, increase plant growth and reduce nitrate, phosphate and ammonium leaching (Crutchfield, 2016). In other studies, biochar was claimed to have agronomic benefits such as reduce disease from *Botrytis cinerea* in tomato (Elad *et al*., 2010), improve soil fertility (Warnock *et al*., 2007)), elevate nutrient availability (Chui *et al*., 2011), decrease CH_4 emission (Steiner *et al*., 2008), enhance soil microbial activity (Liu *et al*., 2011) and remediate contaminated soil (Steinbeiss *et al*., 2009).

The characteristics of biochar, which is highly porous and has large surface area, can retain water and nutrients in the surface soil and also provide shelter for useful organisms to flourish. There were few factors affecting biochar properties. Among them, the main factors are feedstocks, temperature, size of particle and heating rate.

Several studies on biochar production from agricultural waste have taken place. For a maximum yield of biochar for various applications must be appropriate depending on biomass type and also the process conditions such as heating rate, temperature, residence time and others must be optimum (Yaashika *et al*., 2020). A study by a group of researchers from MARDI (Hariz *et al*., 2015) shows that biochar can be locally produced using rotary husk and kiln-drum furnaces for rice husk and coconut shells, respectively. Study in Malaysia on oil palm and rubber seedlings using biochar from paddy waste (rice husk and paddy straw) shows that small addition of biochar enhanced the growth of perennial crops (Hamzah and Suhaimi, 2018). Another study shows that rice husk biochar has a great potential to be applied as an adsorbent based on its porosity (Nurul Farhana *et al*., 2018). Recent study in Bangladesh on two contrast soils shows that application of fertilizer in addition to biochar treatments supported the best plant growth in both soils (Mahmudul Islam *et al*., 2019). Study by Khan *et al*. (2018) indicated that biochar (from poultry manure and sludge) treated soil increase cation exchange capacity (CEC) compared to the corresponding biomass treated soils.

Cocoa pod husk is considered as waste from cocoa. Although it is a waste, a study by Adeyi (2010), showed that cocoa pod husk had high cellulose content (41.92 %), ash content (12.67 %), crude fiber content (33.60 %) and appreciably high char yield. Thus, with these valuable properties, cocoa pod husk can be recycled to be used in cocoa field as biochar. Biochar is charcoal which is made from biomass via pyrolysis and used as soil amendment for both carbon sequestration and soil health benefits.

There is abandon of cocoa pod husk (CPH) in cocoa field environment. If CPH is left idle in cocoa environment, it will lead to serious pest and disease problems especially if the cocoa pod husk is already infected with those pests or diseases, where it can be a good habitat for pest and source of disease inoculum. Without proper management of cocoa pod husk, cocoa farmers will have to spend more money and time to control pest and disease in their farms. In addition, the use of biochar in agriculture is becoming more important due to its good properties that can enhance plant growth, improve soil condition and so on. Therefore, this study is proposed with the objectives to produce biochar from cocoa pod husk (CPH) using simple method and to determine its characteristics.

MATERIALS AND METHODS

This study was conducted at Cocoa Research and Development Centre, Malaysian Cocoa Board, Jengka, Pahang. In this study, biochar from cocoa pod husk was prepared using a simple and affordable technique. The equipment that have been used to prepare CPH biochar are clay bricks, recycled/empty air-conditioner tank, coconut shell as fuel and dried cocoa pod husk.

Preparation of cocoa pod husks

Figure 1 below shows the process of cocoa pod husk biochar production. Cocoa pod husks were collected from cocoa processing centre at the Cocoa Research and Development Centre, Jengka, Pahang and air dried (Figure 1a). Clay bricks were arranged vertically in round form. Then, the empty air-conditioner gas tank was placed at the middle of the round bricks (Figure 1b). Figure 1c shows the opening that has been made at the empty air conditioner tank. CPH was put in an empty tank through this opening. For the charring process, dry cocoa pod husk then, was laid inside the empty tank and coconut husk was placed around the tank and use as fuel to heat the CPH inside the tank (Figure 1c).

Figure 1a

Figure 1b

Figure 1c

Figure 1d

Figure 1e

Figure 1f

Figure 1: The process of cocoa pod husk biochar small scale production: (1a) Air dried cocoa pod husk, (1b) Arrangement of clay bricks and empty tank, (1c) empty tank with opening to put CPH inside, (1d) coconut husk was placed around the tank which has cocoa pod husk inside, (1e) After the burning was initiated, the tank was covered with recycle iron cover, (1f) Burnt coconut husk produced smoke.

Characterization of CPH biochar

The pyrolysed CPH which is also known as biochar was sent to FELDA Analytical Services Laboratory at Pusat Penyelidikan Pertanian Tun Razak, Jerantut, Pahang for further analysis. The analysis included total nitrogen (TN), available phosphorus (AP), exchangeable potassium (exch. K), exchangeable calcium (exch. Ca), exchangeable magnesium (exch. Mg), total carbon (TC) and cation exchange capacity (CEC).

RESULTS AND DISCUSSIONS

Production of biochar

The burning process using coconut husk took approximately one hour to turn all coconut husk to be burnt. After one hour, the cooling process was allowed to occur naturally. The next day, the pyrolysed biochar was removed from the tank. Figure 2 shows the CPH after complete pyrolysis where we can see that there were no ashes in the sample. This indicated that the pyrolysis process was run completely.

Dried cocoa pod husk helps to fasten the pyrolysis process. Low moisture content in the biomass is preferable for biochar formation because of the impressive increases in the heat energy and the reduction of time needed for the pyrolysis process which makes that biochar formation economically feasible when compared to biomass with higher moisture content (Yaashika *et al*., 2020). By charring process, most of carbon dioxide gets tied into more stabilized form and when applied to the soil in the form of biochar effectively sequestered carbon into the soil. It is different from organic matter decomposition where it can produce greenhouse gases such as CO_2 and CH_4 in the atmosphere which lead to climate change.

In this simple method of biochar production, we found that 2 kg of dried cocoa pod husk can produce 700 g of biochar.

Figure 2a

Figure 2b

Figure 2: (2a) Cocoa pod husk after pyrolysis, (2b) Complete pyrolysis, less ash on the biochar.

Nutrient composition in CPH Biochar

Biochar produced from cocoa pod husk was analysed for its nutrient content. Results from the analysis show that biochar from CPH contained high nutrients that are important to plant growth. Analysis of N, P, K, Ca and Mg content in CPH biochar revealed that biochar from CPH contained 1.60 % total carbon, 3.35 % total nitrogen, 0.364 % phosphorus, 9.8 % potassium, 0.78 % calcium, 0.53 % magnesium and 4.02 cmol(+)kg^{-1} cation exchange capacity (CEC).

When compared to nutrient content in raw cocoa pod husk (Table 1), nutrients concentrations in biochar were found to increase compared to raw CPH. This was in accordance with the previous finding as a result of the accumulation of alkaline salts during pyrolysis (Ding *et al*., 2014).

Table 1: Comparison between nutrient content in raw and biochar from cocoa pod husk (CPH).

Nutrient	Raw CPH (%)	Biochar CPH (%)
Total N	0.99	3.35
P	0.091	0.364
K	3.84	9.8
Ca	0.45	0.78
Mg	0.31	0.53

CONCLUSIONS

Preliminary study shows that biochar from CPH can be produced using simple and affordable technique. This technique can be applied by the cocoa farmers in their farms. In addition, biochar produced by CPH has high quality biochar because of its high nutrients concentration compared to raw CPH. These produced biochar then can be applied back to cocoa farm, which can increase soil fertility and thus, increase cocoa yield. In accordance with this finding, the problem of abundant CPH in the cocoa farm surrounding area that leads to pests and diseases habitat will be reduced because all CPH can be used to produce high quality biochar.

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REFERENCES

Andi, B., Muhammad Yunus, F., La Ode, S., Laode Muhammad Harjoni, K. and Rishikesh, S. (2018a). Effects of cocoa pod husk biochar on growth of cocoa seedlings in Southeast Sulawesi, Indonesia. *Asian Journal of Crop Science*, **10(1)**: 22-30.

Andi, B., Muhammad Yunus, F., Tresjia, C. R., La Ode, S. and Laode Muhammad Harjoni, K. (2018b). Cocoa pod husk biochar reduce watering frequency and increase cocoa seedlings growth. *International Journal of Environment, Agriculture and Biotechnology*, **3(5)**:1635-1639.

Chui, H. J., Wang, M. K., Fu, M. L. and Ci, E. (2011). Enhancing phosphorus availability in phosphorus-fertilized zones by reducing phosphate adsorbed on ferrihydrate using rice straw-derived biochar. *J. Soils Sediments*, **11**:1135-1141.

Crutchfield, E. F. (2016). Biochar's effect on plant growth and soil nutrient loss. PhD Dissertation, University of California, Riverside.

Elad, Y., Rav David, D., Meller Harel, Y., Borenshtein, M., Bon Kalifa, H., Silber, A. and Graber, E. R. (2010). Induction of systemic resistance in plants by biochar, a soil-applied carbon sequestering agent. *Phytopathology,* **100**:913-921.

Ding, Dong, Ime, Goa and Lin. (2014). Pyrolitic temperature impact lead sorption mechanisms by bagasse biochar. *Chemosphere,* **105**: 68 - 74.

Hamzah, Z. and Shuhaimi, S. N. A. (2018). Biochar: effects on crop growth. IOP Conf Series: *Earth and Environmental Science*, **215**.

Hariz, A. R. M., Wan Azlina, W. A. K. G., Mohd Fazly, M., Norziana, Z. Z. Mohd Ridhuan, M. D., Tosiah, S. and Nurul Ain, A. B. (2015). Local practices for production of rice husk biochar and coconut shell biochar: Production methods, product characterizations, nutrient and field water holding capacity. *J. Trop. Agric. and Fd. Sc.*, **43(1)**: 91-101.

Khan, T. F., Salma, M. U. and Hossain, S. A. (2018). Impacts of different sources of biochar on plant growth characteristics. *American Journal of Plant Science*, **9**: 1922-1934.

Liu, Y., Wang, H. and Wu, H. (2011). Reducing CH_4 and CO_2 emissions from waterlogged paddy soil with biochar. *J. Soils and Sediments*, **11**:930-939.

Mahmudul Islam, P., Md. Faruque, H.and Zakia, P. (2019). Effect of biochar and fertilizer application on the growth and nutrient accumulation of rice and vegetable in two contrast soils. *Acta Scientific Agriculture*, **3(2)**: 74-83.

Monongo, M. E., Nkeng, G. E. and Njukeng, J. N. (2017). Production and characterization of compost and biochar from cocoa pod husk. *International Journal of Advanced Scientific Research and Management,* **2(2)**: 26-31.

Nurul Farhana, A., Azil Bahari, A., Norhayati, T., Zulkifli, A. R., Wan Azlina, W. A. K. G. (2018). Characteristics of rice husk biochar blended with coal fly ash for potential sorption material. *Malaysian J. Analytical Science,* **22(2)**: 326-332.

Steinbeiss, S., Gleixner, G. and Antonietti, M. (2009). Effect of biochar amendment on soil carbon balance and soil microbial activity. *Soil Biology and Biochemistry,* **41**: 1301-1310.

Steiner, C., Glaser, B., Teixeira, G., Lehmann, J., Blum, W. E. H. and Zech, W. (2008). Nitrogen retention and plant uptake on a highly weathered central Amazonian Ferraisol amended with compost and charcoal. *J. Plant Nutrition and Soil Science*, **171(6)**: 893-899.

Warnock, D. D., Lehmann, J., Kuyper, T. W. and Rillig, M. C. (2007). Mycorrizal responses to biochar in soil - concepts and mechanisms. *Plant and Soil*, **300**: 9-20.

Yaashikaa, P. R., Kumar, P. S., Varjani, S. and Saravanan, A. (2020). A critical review on the biochar production techniques, characterization, stability and applications for circular bioeconomy. *Biotechnology Reports,* **28**: 1-15.