APPLICATION OF WOOD ASH ON ACIDIC SOIL AT LANDFILL AREA

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Abstract

Utilisation of wood ash might improve soil pH especially in landfill area. This study aims to discover the potential of wood ash in decreasing acidity (increase pH) in soil especially at landfill area which is known as disposal site for household waste. Two types of sawdust which are *Acacia mangium willd* sp. and *Endospermum malaccense* sp. were collected and wood ash was produced by pyrolysis process at 600°C for 3 hours. Fourier-transform infrared (FTIR) analysis was then used to determine the chemical composition of wood ash. The landfill soil's plot selected for the experiment was located in Felda Jengka 10 with an area of 100 m^2. Wood ash amount equivalent to 0.1, 0.25, 0.5, and 1 kg/m^2 were used as the pilot test. The usage of wood ash was proven to be effective in increasing the pH (reduce acidity) of the landfill soil. The highest increment of soil pH; up to pH 8.90, was achieved when 1 kg/m^2 of wood ash (*Acacia mangium* willd sp.) was added. This result suggests that utilisation of wood ash on acidic soil will benefit to both soil pH and environment thus possibly can be used as an alternative to the practice of lime at a more reasonable price.

Keyword: Acidic Soil, Soil pH, Wood Ash

Introduction

Uncontrolled landfills such as open dumping produced pollution of air, water and soil that can cause soil acidity resulted from the waste surrounded landfill area (Harshani et al., 2015). Not only that, this method would have affected both environment and people whom living near the vicinity of the landfill itself (Olufunmilayo et al., 2014). Organic wastes produce bacteria which break down waste. Rotting garbage produces weak acidic chemical waste that combine with liquid waste forming leachate and landfill gas (Torobi et al., 2015). As the soil becomes acidic from decaying waste reacting with other rubbishes, the leachate can become toxic. Soil at landfill area also will be affected thus causing soil's pH to become acidic. (Adamcova et al., 2015). The rate of soil pH, to become acidic is between 5 to 6, while for the normal soil, pH reading is always usually greater than 7 which is in between 7.1 to 9.0 (Kouame et al., 2010).

The increasing usage of timber for energy production as an alternative to replace fossil fuel leads to the increase production of wood ash (Bang-Andreasen et al., 2017). Wood ash is the solid residual after combustion of wood (Karltun et al., 2008). The amount of combusted wood is growing yearly, which is consequently reflected in the increasing quantity of wood ash that are considered as waste (Füzesi et al., 2015). Wood ash contains all the major mineral plant nutrients except nitrogen and has a liming effect when returned to the soil (Karltun et al., 2008). According to Olokode et al. (2013), major elements in the wood ash are calcium (Ca), potassium (K), magnesium (Mg), aluminium (Al), iron (Fe), sodium (Na), manganese (Mn), phosphorus (P) and sulphur (S). Wood ash reacts easily with water. When the ash gets in contact with water the pH of the solution becomes high as the oxides and hydroxides in the ash dissolve and hydroxide ions are formed such as CaO or $Ca(OH)_2$ (Karltun et al., 2008).

Thus, this study is important to assess the potential of wood ash as lime replacement in increasing soil pH. Perhaps, the outcomes will benefit local authorities specifically to lower the cost of reducing soil acidity in landfill that can be gazette as a green area when disclosed.

Materials and Methods

Sample Collection and Preparation

The study site was experimented at a landfill area located in Felda Jengka 10, Pahang coordinated at 3°50′05.22″ N 102°34′09.71" E. The sample of two types sawdust, which are *Acacia mangium willd sp* and *Endospermum malaccense sp* were collected from a wood workshop in UiTM Jengka, Pahang. About 5 kg of sawdusts were dried in an oven at temperature 105°C for 12 hours. Then, it was place in a crucible with lid and put in a muffle furnace at 600°C for 3 hours. The result was wood ash material which was then cooled overnight for further analysis.

Characterisation of Chemical Compositions in Wood Ash

The chemical compositions of wood ash were determined using Perkin Elmer Spectrum TM 100 FTIR-ATR. The function of FTIR-ATR is to analyse all chemical compositions and to det ect the presence of functional groups in wood ash (Esteves et al., 2013).

Application of Wood Ash on Landfill Soil

The initial pH of landfill soil was taken before adding the wood ash. The pH of wood ash also was measured. These pH values were determined using a pH meter. The designated land was divided into 24 plots (1m x 1m per plot) allowing the investigation of the effects of different loads of wood ash using two types of wood ash. The experiment was composed based on different portions of wood ash, 0.1, 0.25, 0.5, and 1 kg/m^2 for both wood ash species. All portions of wood ash were carried out in three replicates (n=3) so that the total were 24 plots. The soil pH was taken after a week.

Result and Discussion

pH and Chemical Compositions in Wood Ash

The wood ash was discovered to slightly possess alkaline properties with a pH of 13.50 for *A. mangium* and 13.15 for *E. malaccense*. The alkaline properties of wood ash were also proven by Füzesi et al. (2015) with a result of 13.0. **Figure 1** and **Figure 2** show the chemical compositions of *A. mangium* and *E. malaccense*, respectively. The absorbance of IR spectrum was obtained at a range of 400 to 4000 cm^{-1}, using a typical 32 scanning and 4 cm^{-1} resolutions (Srivastava et al., 2015; Ab Manan & Ab Aziz, 2018). The FTIR spectrums from **Figure 1** and **Figure 2** both indicated the presence of a strong band around 1464.64 02 cm^{-1}, 1435.72 02 cm^{-1} and 1312.29 cm^{-1} where this describes the characteristics of the C-O stretching mode of carbonate together. The peak for C-O stretching mode of carbonate with a narrow band in **Figure 1** is around 872.02 cm^{-1} of the bending mode and 873.83 cm^{-1} in **Figure 2**. Both peaks represent CO_3^{2-} component centered the calcite and proved that the wood ash from both species possessed calcium carbonate (Eisa et al., 2015).

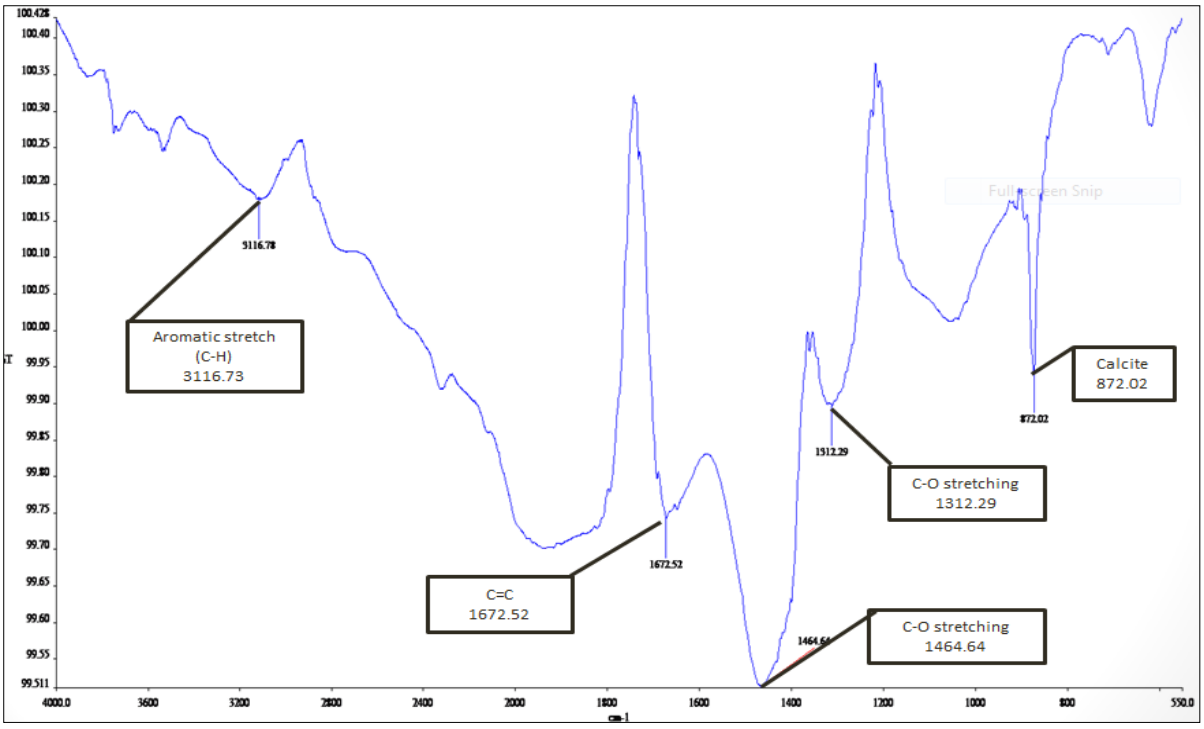

Figure 1 FTIR spectra of *A. mangium* wood ash labeled with the respective chemical composition.

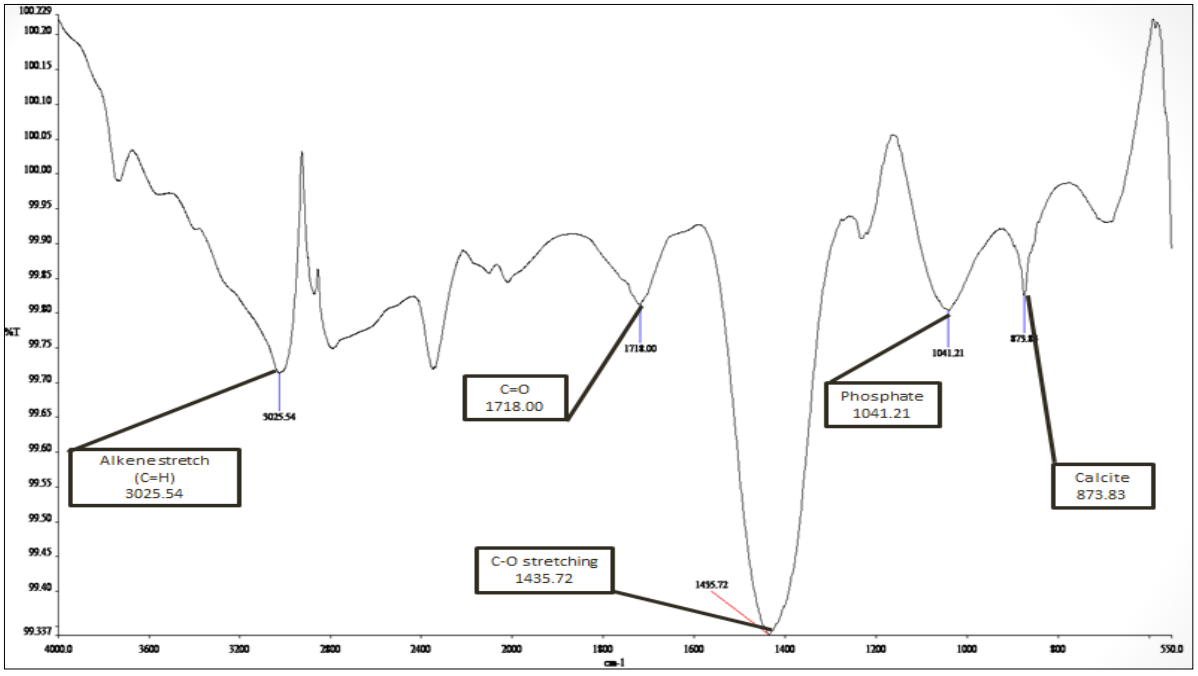

Figure 2 FTIR spectra of *E. malaccense* wood ash labeled with the respective chemical composition.

Effect of Wood Ash Application on Acidic Soil

The pH of the soils in the beginning of experiment was 5.71 and is considered as very acidic. There was an increasing pattern in soil pH when wood ash was added from 0.1, 0.25, 0.5, and 1 kg/m^2 for both wood ash species. This proves that pH increases with the increasing amount of wood ash. The wood ash is slightly alkaline; therefore, it is practical for the soil pH in landfill to increase. **Table 1** exhibits the utilisation of wood ash on acidic soil in landfill area.

The highest increment of soil pH was recorded when the wood ash was added sequentially up to 1 kg/m^2 for both wood ash species. The highest pH value which is 8.90 was recorded for *A. mangium* as seen in **Table 1**. A similar study was reported by Malhi (2012) for pH value of soil that increased after adding similar type of wood ash. Wood ash is similar to lime which supply nutrients such as phosphorus, providing calcium and magnesium and also alkaline characteristic (Risse & Gaskin, 2010).

Table 1 Changes of soil pH after utilization of wood ash

Amount of wood ash added (kg/m^2)	**Soil pH**	
	***Acacia mangium willd* sp.**	***Endospermum malaccense* sp.**
0	5.71	5.71
0.10	7.71 ± 0.04	7.54 ± 0.02
0.25	8.04 ± 0.03	7.93 ± 0.02
0.50	8.61 ± 0.02	8.21 ± 0.02
1.00	8.90 ± BDL	8.54 ± 0.03

Results represented in mean ± standard deviation (SD); BDL = below detectable limit; n = 3 replicates

Conclusion

Wood ash can be used as lime replacement on acidic soil especially in landfill area since it has been proven in this study that there was an increase in pH of acidic soil when wood ash was applied. Among all wood ash amounts used in this study, 1 kg/m^2 was found to be the best compared to others amount in increasing the soil pH; 8.90. This suggests that wood ash could be applied as an alternative to lime material in increasing the pH of acidic soils at normal alkaline pH in between 7.1 to 9.0. Nevertheless, further comprehensive research is needed in ensuring the advantages of wood ash for soil improvement.

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Conflict of interests

The authors declare that there is no conflict of interest.

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