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Evaluation of Soil Physical and Chemical Characteristics Around Wood Waste Production Site in Emeyal Ii, Bayelsa State

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***Abstract**: Wood waste is generated from various sawmills across the country is a popular organic material usually found to be scattered or accumulated in soils around timber processing sites, and often suitable for use as a growing medium as well as a supplement in animal farms such as poultry birds. This study was aimed at assessing the soil's physical and chemical characteristics around the wood waste production site in Emeyal II, Bayelsa State. Soil samples were collected (0-20cm depth) from two (2) sampling locations; wood waste production and the control sites (an area outside the wood waste production site. The soil physical and chemical properties of the two experimental sites were analyzed using standard procedures. The results of this study revealed that the textural class of soil in the two sampling locations was sandy loamy with sand (72.59 and 69.50%) and silt (17.02 and 18.17%) proportions for wood waste production and the control sites, respectively. The bulk density and total porosity for wood waste production site were lower than that of the control. The pH value of the wood waste production site was relatively lower than that of the control. The contents of organic carbon, organic matter, potassium, calcium, magnesium and cation exchange capacity at the wood waste production sampling location were significantly ($P<0.05$) higher than that of the control. This study suggests that although the use of wood waste has been shown to widen the carbon-to-nitrogen ratio of the soil, judicial application of organic manure from wood waste to nutrients deficient soils could be a beneficial alternative to chemical fertilizers.*

Keywords: *Soil, characteristics, wood waste production site, Emeyal II, Bayelsa State*

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1.0 Introduction

Wood residues such as sawdust, wood chips and shavings are generated in huge amounts yearly from biomass (Goyal *et al*., 2008). This large amount of solid waste, especially sawdust, although a source of energy, often constitutes a nuisance to the environment. It is estimated that about 1.5 million tons of sawdust and 5.2 million tons of wood residues are produced annually in Nigeria, respectively (Safie *et al*., 2017). In recent times, wood residues have been regarded as an important material that should not be rated as a mere useless material to be discarded, but as a useful resource from which energy, fuel and other valuable products can be harnessed (Owoyemi *et al*., 2016, Peter *et al*., 2017). Wood waste is a popular organic material and readily available, especially in forested areas such as Nigeria and other tropics, where lumbering and timber processing activities are prevalent (Maboko and Du-Plooy, 2013). Wood waste is usually produced both in small and large proportions in secondary and primary forested areas. It is important to note that sawdust is usually found to be scattered or accumulated in soils around timber processing sites. It has been shown that sawdust is economical relative to other imported growing media, and it is suitable for use as a growing medium and as a supplement in animal farms such as poultry birds. Researchers have reported the favourable effect that organic growing media have on plant growth (Tzortzakis and Economakis, 2008), as it increases the porosity and water retention of the growing medium (Marinou *et al*., 2013). Favourable and enhanced soil physical characteristics such as biodegradability at an acceptable rate, low superficial specific gravity, high porosity, high water retention, moderate drainage and high bacterial tolerance have been reported in soils and growth media supplemented with sawdust (Maharani *et al*., 2010). It is also widely used throughout the world (Niederwieser, 2001) and has been used as an important growth medium for the commercial production of some crops.

Bayelsa State is characterized by mainly marshy and aquatic terrains. Even though wood waste has been commercially used for many years, data is lacking that describes whether sawdust is suitable in soils concerning soils such as marshy areas of Bayelsa State. Wood is an organic waste material often generated in timber processing industries. Although it could be utilized as organic manure, its low biodegradability may render it a nuisance around habitable areas and cultivated lands. Its high carbon-to-nitrogen ratio in soils also reduces the rate of its usage comparable to other organic manure (Etukudo *et al*., 2011). Therefore, this research was conducted to evaluate the characteristics of soil around timber processing sites relative to normal soil.

2.0 Materials and Methods

2.1 Study area

The study area Emeyal II is located within the lower section of the upper floodplain deposits of the sub-aerial Niger Delta. Geographically, it lies between latitudes 4.8277° N, and longitudes 6.3386° E. The area is bounded on the east by Yenagoa, the capital of Bayelsa State and on the South by Brass and Nembe local government areas of Bayelsa State, to the West by southern Ijaw and Ahoada-west local government areas of Bayelsa State and Rivers State, respectively. The area is characterized by marshy terrain with the major occupation of the inhabitants being farming and fishing. The soil and climatic conditions are characterized by that of a typical tropical region (Niger Delta Source, 2014).

2.2 *Collection of soil samples*

Soil samples were collected (0-20cm depth) from two (2) sampling locations; the wood waste production site and the control (an area outside the wood waste production site) in triplicates, giving a total of six (6) representative samples. Soil samples were obtained at a distance of 2m away from the wood waste production site. The samples were collected using an acid-clean soil auger pack in a well-labelled black polythene bag and taken to the laboratory for analysis.

2.3 *Analysis of soil physical and chemical characteristics*

The soil samples were air-dried at room temperature depending on moisture content for two (2) weeks and crushed to pass through 2mm mesh sieve. Sub-samples of soil from each location were further ground to pass through a 100-mesh sieve for determination of organic matter. The rest samples were then analyzed for both physical and chemical properties of the soil. Standard methods were used to analyse soil samples for physico-chemical properties (International Institute for Tropical Agriculture, 1979). Particle size distribution analysis was done by the Hydrometer method (International Institute for Tropical Agriculture, 1979). Soil pH was measured in water at a ratio of 1:1 (soil: water) by a glass electrode pH meter (Mclean,1982). Bulk density was determined by the method described by Blake and Hartge (1986), total porosity was calculated from the soil bulk density as the fraction of total volume not occupied by soil assuming a particle density of 2.65 gm^{-3} (Blake and Hartge, 1986). Organic matter was determined by wet dichromate acid oxidation method (Nelson and Sommers, 1982). Exchangeable Bases of soils (Ca, Mg, K and Na) were extracted with 0.05N NH_4OAc buffered at pH 7.0 (Thomas, 1982). Exchangeable K and Na contents of the extracts were read on an EEL photometer. Exchangeable Ca and Mg were determined by titration method (International Institute for Tropical Agriculture, 1979). Total Exchangeable Acidity (H^+, Al^{3+}) was extracted with 1 N KLC (Thomas, 1982) and determined by titration method 0.05N NaOH using phenolphthalein as an indicator. Effective Cation Exchangeable Capacity (ECEC) was determined by taking the summation of exchangeable bases and total exchangeable acidity (Okalebo *et al*., 2002). Percentage base saturation (BS%) was calculated as the percentage of the sum of exchangeable bases divided by ECEC. The percent organic matter (%OM) was calculated from the percent organic carbon (OC%) measured using Walker-Black (1934) wet oxidation method. Total nitrogen (TN) was determined using the modified Kjeldahl distillation methods (Juo, 1979).

3.0 Results and Discussion

3.1 *Soil physical properties around the sawdust production site*

The physical characteristics of the experimental soil are presented in Table 1. The textural class of soil in the two sampling locations was sandy loamy with sand proportions of 72.59 and 69.50%, and silt proportions of 17.02, 18.47, and clay proportions of 10.39, 12.03% for the control site and wood waste site, respectively. The bulk density and total porosity for wood waste sampling locations were lower than that of the control (Table 1). The benefits of using wood waste to generate compost are its favourable physical properties such as low apparent specific gravity (density), high porosity, high water retention, moderate water drainage, high bacteria tolerance, and biodegradability at an acceptable rate; in this way sawdust-composting process can then be enhanced (Kitsui and Terazawa, 1999). The physical properties of sawdust can also be modified by combining the sawdust particles of various sizes in particular proportions (Houghton *et al*., 2002; Agnew and Leonard, 2003; Dikinya *et al*., 2006). This modification creates an ideal environment to remove moisture from sawdust waste efficiently, and also for aerobic bacteria to thrive and decompose waste effectively into carbon dioxide and water without generating odor (Terazawa *et al*., 1999). A similar pattern was reported by Paulrud *et al*. (2002) which stated that particle size distribution has been associated with the size of sawdust and the mill types that are used for producing sawdust. Moreover, Houghton (2002) reported that the size of the knife used will affect particle size distribution and that increasing the size of the knife had also been associated with larger particle size.

Table 1: Soil physical properties around wood waste production site

Parameters	**Control site**	**Wood waste site**
Bulk density (g/cm)	1.30±0.12	1.82±0.61
Total porosity (%)	35.00±0.20	46.00±0.90
Sand (%)	72.59±0.40	69.50±0.31
Silt (%)	17.02±0.32	18.47±0.24
Clay (%)	10.39±0.23	12.03±0.45
Textural class	Sandy loam	Sandy loam

Mean ± Standard error from 3 replicates

3.2 *Soil chemical properties around wood waste production site*

The pH value of wood waste soil was relatively lower than that of control. The contents of organic carbon, organic matter, potassium, calcium, magnesium and cation exchange capacity of wood waste soil sampling location were significantly ($P<0.05$) higher than that of the control. Conversely, the content of total nitrogen of the wood waste soil sampling location was significantly ($P< 0.05$) lower than that of control (Table 2). The increased importance of wood shavings includes an increase in the amount of water retained at field capacity as well as nutrient availability in the soil as an organic resource. Wood waste materials have been successfully used in the field to control erosion on slopes and exposed soil surfaces (Ferguson, 2016). Their primary benefits are to enhance the ability of soil to support plant growth by fostering the various activities that plants need from water retention to microbial life and nutrient supplementation (Etukudo *et al*., 2011). In Nigeria, where sawdust is heaped and burnt in ash (Ojeniyi and Adejobi, (2002) and Odedina *et al.* (2003), studies showed that sawdust had a significant effect on the yield of vegetables and N, P, K, Ca and Mg contents. (Odedina *et al.* (2003) stated that information is scarce on the optimum level at which sawdust ash and wood ash can be used to raise seedlings in the nursery. Organic manure is a source of plant essential nutrients and is beneficial to soil physical properties. The addition of Organic manure to fields can improve soil pH, cation exchange capacity, water-holding capacity and soil structure (Awodun, 2007). Furthermore, farmers believe that the application of Organic manure can reduce wind erosion (Geneva, 2021). Organic manure breaks down more slowly in soil than inorganic fertilizers. It acts as a slow-release fertilizer which provides nutrients over a longer period and often has a residual effect which may last for one or two further growing seasons (Anda *et al*., 2008, Milnes and Haynes, 2004).

Table 2: Soil chemical properties around wood waste production site

Parameters	Control site	Wood waste site
pH	5.10±0.12	4.48±0.52
Organic carbon (%)	0.44±0.03	6.30±0.24
Organic matter (%)	2.17±0.20	9.09±0.51
Total nitrogen (%)	0.17±0.04	.07±0.01
Potassium (Cmol/kg)	0.66±0.02	0.80±0.02
Calcium (Cmol/kg)	2.11±0.13	3.02±0.22
Magnesium (Cmol/kg)	2.30±0.22	3.48±0.16
CEC (Cmol/kg)	2.50±0.15	5.66±0.18

****Mean ± Standard error from 3 replicates**

4.0 Conclusion

The study demonstrated the potential of wood waste-enriched soil as an alternative management option for improving the nutrient status of farmlands. Although the application of wood waste has been shown to widen the carbon-to-nitrogen ratio of the soil, appropriate utilization of wastes generated from sawmills could improve the contents of organic carbon, organic matter, potassium, calcium, magnesium and cation exchange capacity of the soil. Therefore, judicial application of organic manure such as wood waste to nutrient-deficient soils could be a beneficial alternative to chemical fertilizers.

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Compliance with Ethical Standards

Declarations:
The authors declare that they have no conflict of interest.

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Authors' Contributions

Onu designed and carried out all the components of the work