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Recycling of Sawdust and Water Hyacinth into Compost

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ABSTRACT:*Studies on adequate mix ratio of water hyacinth (EicheeorniaCrassipes) to wood sawdust are scarce. In this study water hyacinth was composted with wood sawdust as the bulking agent in the ratio of 9:1 using windrow method. Composting temperature above 40°C was reached which favours decomposition and the moisture level was in the range of 45 to 66.7%. The final carbon/ nitrogen ratio of 35:1 was promising for compost use in agriculture.*

KEYWORDS: *composting processing, wood sawdust, water hyacinth, seaweed, compost, Niger Delta*

I. INTRODUCTION

The disposal of organic waste from timber industry has become an environmental problem especially in the Southern part of Nigeria. In Nigeria, the major driving factor for timber is the increasing global demand for tropical hardwood as well as local use as fuel wood [1]. Babanyara et al. [1] reported that the deforestation rate in the Southern region is 1.36% and is double the national average. The current practice of having wood sawdust (WS) burnt in the open or disposed of in the dumpsites is not an acceptable practice, due to its tendency to cause both land, air and water pollution (Figure 1). Water hyacinth, a type of seaweed is becoming a hazard to water transport especially in the Niger Delta region of Nigeria. Access to harbours and docking areas can be seriously hindered by mats of water hyacinth (Figure 2). The region relies mostly on water transport due to their topography which makes land transport a major challenge.

Figure 1. A heap of Wood sawdust

Figure 2. Water hyacinth covering a river

Composting is a method of decomposing and stabilizing organic waste. It could be an appropriate way of recycling these wastes and at the same time produce useful material in the form of compost [2]. The use of organic fraction of municipal solid waste in composting processes has been investigated [3-6]. The transformation of organic compounds to more stable organic matter during composting is due to succession of activities by different microorganisms. A process governed by various factors such as the nature of starting material and composting conditions [3, 4]. Compost acts as soil conditioner since it improves soil structure, water retention and can slowly release its plants nutrients [3, 5, 7]. Thus, compost is useful for gardening, landscaping or house plants.Composting as an aerobic process needs the presence of oxygen (air) which influences microbial activity. The chemical and physical composition of waste also determines the rate of aeration required in the process, hence the use of bulking agent during composting to facilitate the free passage of air. A bulking agent is an organic/inorganic material of sufficient size to provide support and maintain air spaces within the composting matrix [7]. Examples include woodchips (25 - 40 mm size), waste paper and peanut shells. Aeration is important because it supplies oxygen to support aerobic metabolism**,** controls temperature andremoves moisture, carbon dioxide and other gases.The moisture content of water hyacinth is high, thus there is need for addition of dry materials such as sawdust which acts as a bulking agent. The bulking agent absorbs the moisture to create suitable aeration within the composting mass. The importance of using bulking agent during composting have been investigated by other researchers [3-5, 8, 9] even though there is no consensus on the efficacy of bulking agents in composting. The objective of this study was to evaluate the feasibility of producing compost from wood sawdust and water hyacinth. The selection of these wastes was based on their potentials for creating environmental hazards.

II. MATERIALS AND METHODS

Water hyacinth and wood sawdust as bulking agent were used in this study. Water hyacinth was collected from Elebele town in Ogbai local government area of Bayelsa state in Nigeria. The wood sawdust was collected from a local sawmill at Emuoha local government area of Rivers state also in Nigeria. Sawdust composed of fine particles of wood are the main by-product from sawmills. The materials were handpicked for non-biodegradable materials. The water hyacinth was allowed to wilt for 10 days to remove excess moisture after which, it was mixed with the sawdust in a ratio of 9:1 (w/w). The composting pile was turned periodically every 4-5 days for proper mixing and allowed to stand out-door for a period of 23 days using open windrow method (Figure 3). Care was taken during the turning process to avoid loss of heat from the composting pile which could slow down decomposition. The initial moisture content of the composting mix was 66.7% on weight basis.

Figure 3 Compost mix on the first day

Figure 4: Finished compost after 23 days

Chemical characterization : The Volatile solids content (% dw) of the feedstock was determined by the weight loss after ignition of the oven dried sample in a muffle furnace at 550°C for 2 hours according to standard methods [10]. The volatile content is measured as the dried residues of the sample after organic material are burnt at temperature of 550°C. Total nitrogen (TKN) was determined by Kjeldahl steam distillation method as described by Benkacoker and Ekundayo [11]. Organic carbon was determined using the Wakley-Black method described by Adekunle et al. [5]. Changes in temperature during composting were monitored on daily basis for 23 days using mercury-in-glass thermometer. The pH of the water extract was determined according to standard methods [10]. This was done with calibrated HQ 40d portable pH meter (HACH U.S.A) using appropriate dilutions (usually 1:2) of the water extract. Feedstock analyses are shown in Table 1.

Table 1 Characteristics of water hyacinth and sawdust (dry weight)

Parameter	**Water hyacinth**	**Wood sawdust**
Carbon (%)	47.5	54
Nitrogen (%)	1.54	0.84
Total solids (%)	85.5	97
Volatile solids (%)	14.5	2.6

III. RESULTS AND DISCUSSIONS

Figure 4 shows matured compost that is dark in color with no offensive odor. The initial moisture content was 66.7% on weight basis which could be viewed as an upper limit. The moisture level was monitored throughout the composting process making sure it did not fall below 40%. Reduction in moisture level is an indirect measure of microbial activity given that water evaporation is influenced by the microbial generated heat within the composting mass. The trend in pH was an initial rise to alkali levels as shown in Figure 5. It then decreased to neutral levels and stabilized around 7.3 after 23 days which falls within the recommended range of 6.5 – 8.5 suitable for matured compost. The pH is an important parameter for evaluating compost maturity and stability. It can be used for monitoring the condition of the organic matter as it stabilizes during composting. An acidic pH value shows lack of compost maturity [12]. Figure 6 shows variation in temperature during the 23 days of composting. The composting temperature was higher than the ambient temperature and was sustained until the peak recorded in day 15.

The choice of water hyacinth to wood sawdust ratio (9:1) was based on the design windrow compost wizard, customized application software developed for this study. The software requires input data such as organic carbon (%), total Kjeldahl nitrogen (TKN %), total solids for both raw material as shown in Table 1. It also requires desired carbon and nitrogen content of the mixture. Inputting these data into the program and executing it produces an output such as wet weight and dry weight ratio for both materials and mix ratio for both material needed for composting. The temperature within the first three days of the composting process was between 0 to 7°C as shown in Figure 6. This temperature range encourages the psychrophilic bacteria. From day 4 to 12, the temperature range was 10 to 37°C which supports the mesophilic bacteria. The peak temperature (~ 45°C) occurred on day 15, and it is expected that the thermophilic bacteria will replace the mesophilic bacteria. Since temperature plays a role in microbial succession, there is need to monitor composting temperature. The efficiency of the composting process drops at higher thermophilic levels [13, 14]. This suggests that variations in temperature also influences the organisms found within the compost matrix.

Temperature affects microbial activity because microorganisms have optimal temperatures above which their growth rate is affected. Heat is a byproduct of composting process. This heat remains in the composting mass because of good insulating properties of the composting matrix. It is believed that as the compost reaches maturity, the temperature starts falling until it stabilizes at which time the organic materials would have nearly been oxidized. This temperature gradient is observed in the present study (Figure 6) since the peak temperature was around day 15 after which the temperature started decreasing. The temperature decrease can be referred to as the cooling phase when the amount of readily available organic substrate becomes rate-limiting factor resulting in decrease in microbial activity as well as heat produced. During the thermophilic phase, most human and plant pathogens are destroyed. The mesophilic bacteria have been identified as important during composting process since they are mostly involved in the decomposition of organic matter [5]. Generally, composting temperature should not be more than 50 to 60°C, a criteria met in the present composting process.

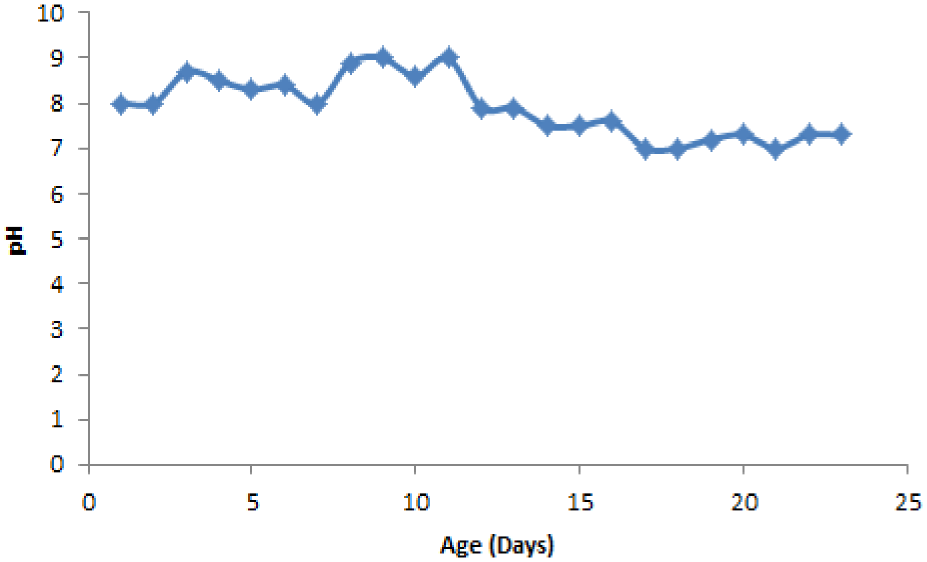

Figure 5. Variation of the pH with composting time

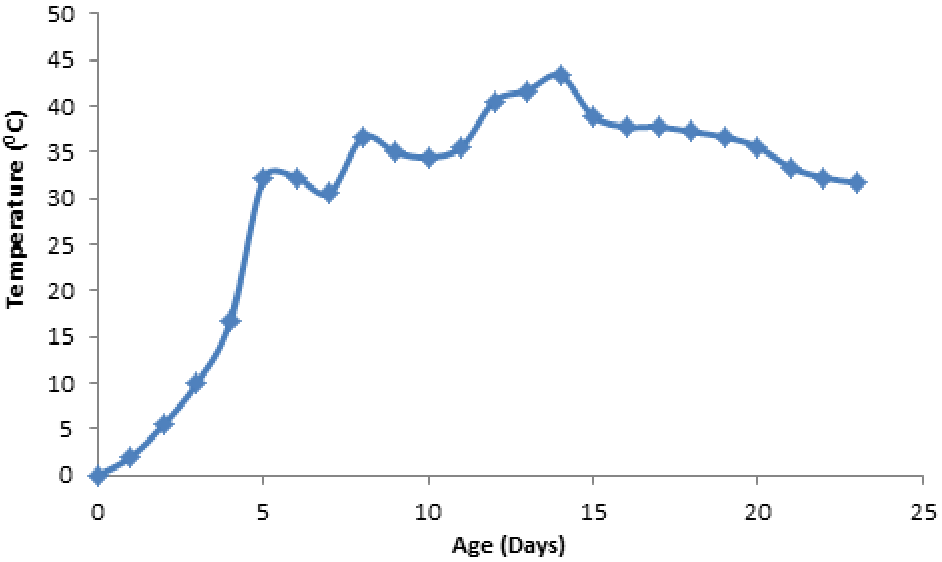

Figure 6. Temperature variations during composting process

IV. CONCLUSION

Wood sawdust and water hyacinth has been successful transformed into compost. The success represents an alternative method of waste disposal and would reduce the risk associated with incineration of wood sawdust. The attainment of high temperature favoured sanitation of the compost. This suggests that that the composting process would have stabilized the organic matter as well as suppressing pathogenic microorganisms, thereby allowing the compost generated to be used as soil conditioner.

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