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Effect of Different Sources of 'Browns' and 'Greens' On the Quality of Compost

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Abstract
Studies on the quality of compost produced from different sources of carbon ('Browns') and nitrogen ('Greens') was conducted in a screen house in the Teaching and Research Farm of Rivers State University, Port Harcourt. The browns included Dry leaves (DL), wood shavings (WS) and office waste paper (OFW) and the greens were poultry manure (PM) and kitchen fruit wastes (KW). These gave 6 combinations namely DL+KW, DL + PM, WS+KW, WS+PM, OFW + KW and OFW + PM. The composts produced were also analyzed for pH, % carbon, % organic matter, total nitrogen and C:N ratio. Results showed that the total nitrogen of the greens was 1.3 and 1.5% for KW and PM, respectively. The carbon content of the browns was 5.54, 4.82 and 4.29% for WS, DL, and OFW, respectively. The organic matter content of the composts made with WS were significantly higher than those made with DL and OFW (p<0.05). Generally, composts produced with KW had higher % total nitrogen than those produced with PM, as a source of green. The pH of all the composts produced were not different ranging from 6.3 to 6.6, with the exception of WS+KW with a pH of 7.4. The C:N ratio of the composts ranged between 4.4 to 11.2, when compared with 28.00 for the soil of the immediate environment. These suggests that the use of both kitchen and office wastes can be used to produce quality compost. This approach, in addition, to adding nutrients to the soil will reduce landfill wastes and their contribution to climate change and encourage good environment.

Keywords*: 'greens' and 'browns', compost quality, soil enrichment, carbon sequestration*

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I. Introduction

The term composting has severally been defined as the natural breakdown process of organic residues which transforms raw organic waste materials into biologically stable, humic substances that make excellent soil amendments; by the activities of microorganisms (Agbede 2009, Stan *et. al*., 2009, Bastda*et. al.,* 2010, Diacono and Montemurro, 2010). It involves the recycling of various organic materials, regarded as waste products, such as animal manure, crop remains, municipal garbage, kitchen waste, hedge trimmings and non seeding weeds (Mohammed *et al*., 2004, Mohammed *et al* 2016).

Compost provides nutrients as fertilizer to the crop (Diacono and Montemurro *et. al.* 2006, Diacono and Montemurro *et. al.* 2009, and Tejala *et. al.,* 2009), acts as soil conditioner. (Isirimah*et.al.* 2010, Ogbonna *et.al*. 2012 and Agegnehu*et. al.,*2014), introduces beneficial colonies of microbes in the soil; which interacts with the soil and plant roots to improve the soil structure (Lal 2006, Lal 2007, Olabode *et al.,* 2007, Farrell and Jones 2009, Adugna 2016 and Kranz *et. al.,* 2020). An improved soil structure will increase the soil water retention ability and control soil erosion (Hemmat *et al.,* 2010 and Adugna, 2016). Also as landfill cover, compost provides a healthy utilization of waste organic materials. Organic waste in landfills generates, methane, a potent greenhouse gas. By composting wasted food and other organics, methane emissions are significantly reduced. Compost also provides carbon sequestration, by storing it in the soil instead of releasing it to the air.

Green waste is generally considered a source of nitrogen and contains large concentration of nitrogen, including food waste, grass clippings, garden trimmings and fresh leaves, industrial kitchen waste, fruit wastes ("Natural Rendering" 2002, Isirimah*et.al.* 2010). Brown wastes on the other hand are any biodegradable waste that is predominantly carbon based. They include dried vegetation and woody material such as fallen leaves, straw, woodchips, limbs, logs, sawdust, wood ash paper and plain cardboard.

With the wide range of varieties of sources of browns and greens useable for composting, there is need to assess the quality of the compost produced from their various combination.

II. Materials And Methods

Study Site

This study was carried out in Rivers State University Teaching and Research Farm, Port Harcourt. The site is located at longitude 4.8^0N and 7.0^0E with an elevation of 18m above sea level, with mean annual rainfall of 3,000mm to 4,500mm, relative humidity of 69.08% and mean annual temperature of 22^0C to 29^0C (Uko and Tamunobereton-Ari., 2013).

Experimental Materials

The sources of carbon(Browns) used were Wood Shaving (WS), Dried Leaves (DL) and Office Waste (OFW) while the sources of nitrogen (Greens) used were Kitchen waste (KW) and Poultry dropping (PD).Wood shavings were collected from a local timber market located Port Harcourt Rivers State, Nigeria. Dried leaves and office waste was collected from Rivers State University Premises. Kitchen waste was procured from a local fruit garden market, poultry droppings and topsoil from Rivers State University Teaching and Research Farm.
The various combinations of these browns and greens gave the 6 treatments in this research. The treatments include: OFW+PD, DL+PD, WS+PD, OFW+KW, DL+KW and WS+KW.

Compost preparation

Composting was done in a screen house at the Rivers State University Teaching and Research Farm. Compost piles cubicles with dimension 1m x 1m x1m were constructed using wire mesh and iron poles. The organic materials were chopped to small sizes and piled in successive layers in a ratio of 3:1 of brown to green. The piles were covered with thick black polythene waterproof material to conserve heat. The compost piles were turned weekly with a garden fork and temperature measured with a soil thermometer. Activated EM1 solution (Orji and Akukalia 2021) was used to water the piles every two weeks. This helped to enhance decomposition and eliminated bad smell. The composts were ready in three months. Each treatment had a separate compost pile.

The compost materials and the composts produced were analyzed for pH, total nitrogen, organic carbon, organic matter and carbon:nitrogen ratio. The pH was determined in a compost water ratio of 1: 2.5 using pH meter with a glass electrode. Organic carbon was determined by Walkey and Black method and total nitrogen by micro-Kjedahl method. The topsoil of the immediate surrounding of the experimental site was also analyzed for the above parameters.

III. RESULTS AND DISCUSSION

Properties of the compost materials used

Some chemical properties of the compost materials used for composting are as shown on Table1.The pH values of the various sources of were generally near alkaline, ranging between 6.4 to 6.9 (Table 1). The wood shaving (WS) had the highest pH among the sources of Carbon (6.9) while the kitchen waste (KW) had the highest pH value (6.8) among the sources of nitrogen. However, these values were not significantly different. These differed with the pH of the soil which is 5.9.

The percentage carbon and organic matter contents of the compost materials were generally high; for both the sources of brown and green (Table 1). The percentage of total nitrogen contents of the green were significantly higher than those of the browns. It was 1.30 to 1.50% for PM and KW respectively. The browns were in the order 0.17, 0.19 and 0.46 % for OFW, WS and DL respectively. The C:N ratio values for the browns are significantly wider than the greens. This high nitrogen and low C:N ratios is what distinguishes the greens from browns.

The topsoil of the site is a sandy loam, with 78.8% sand, 17.4% silt and 14.0% clay. It has an average pH value of 5.9, low in percentage total nitrogen (0.05%) and percentage organic matter (2.41%) with a C:N ratio of 28.0. In comparison with the topsoil, the browns have C:N ratios closer to soil than the greens.

Table 1: Some properties of the compost materials used and the surrounding topsoil

Properties	Soil	BROWNS			GREENS	
		DL	WS	OFW	PM	KW
pH	5.9	6.5	6.9	6.5	6.4	6.8
%C	1.4	4.82	5.54	4.29	4.81	4.95
%O.M	2.14	8.30	9.84	7.40	8.0	8.53
% TN	0.05	0.46	0.19	0.17	1.50	1.30
C:N Ratio	28.00	10.47	28.65	25.54	3.21	3.81
%Sand	78.4	-	-	-	-	-
%Silt	17.4	-	-	-	-	-
%clay	14	-	-	-	-	-
Textural class	Sandy	-	-	-	-	-

	loam

Quality of the composts produced

Results of the effect of different compost materials on the pH of compost produced, is as shown on Fig.1. Composting with WS+KW gave a higher pH value of 7.4, than their individual pH values of 6.9 and 6.8 for WS and KW, respectively. WS+PM gave a lower pH of 6.3. There were no differences in pH when DL was composted with KW or PM and also when OFW was composted with KW or PM.

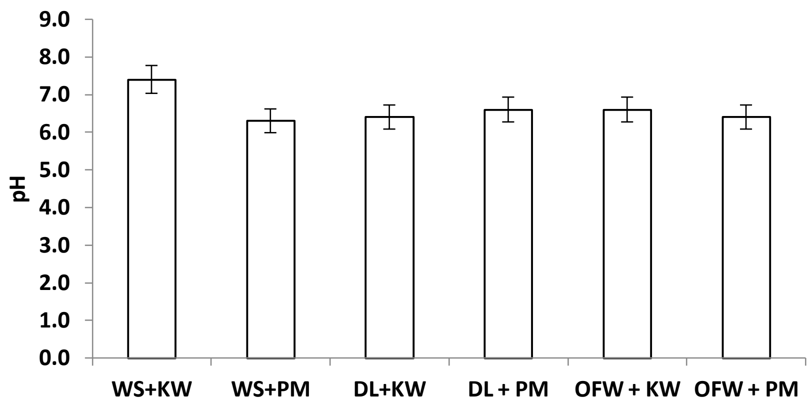

Fig.1: pH of composts produced

Organic matter content for all compost produced ranged between 7.26 to 9.87% (Fig. 2). WS and composts made with WS (WS+PM and WS+KW) gave the highest percentage organic matter content; when compared with DL and OFW composted with PM or KW. Organic materials are reported to have high organic matter contents (Isirimah*et. al*. 2010, Ogbonna *et. al*. 2012, Bouajila and Sanaa 2011 and Mohammed *et. al*. 2016). Results showed that there were no significant differences in organic matter contents when either of the three browns (WS, DL and OFW) were composted with any of the greens (PM or KW). Therefore, composting had no effect on the organic matter content of the composting materials used.

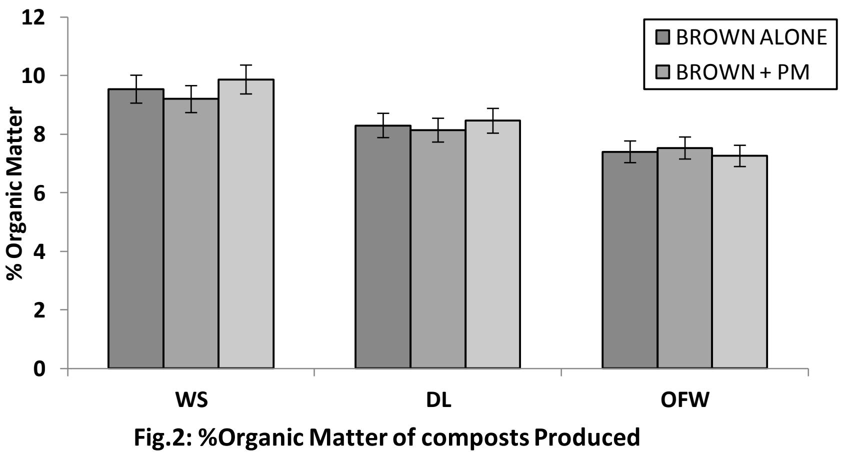

Fig.2: %Organic Matter of composts Produced

The total nitrogen contents were generally higher when the organic materials were composted together, than separately (Fig. 3). Total nitrogen increased with composting the WS and OFW with either PM or KW. However, there was no significant differences in the total nitrogen content when DL was composted with either PM or KW. The Total Nitrogen content of WS was increased by 163% when it was composted with PM and by 584% when composted with KW. Generally, composting with KW as green increased nitrogen contents better than composting with PM. This suggests that KW better enhanced the mineralization of WS better than the PM.

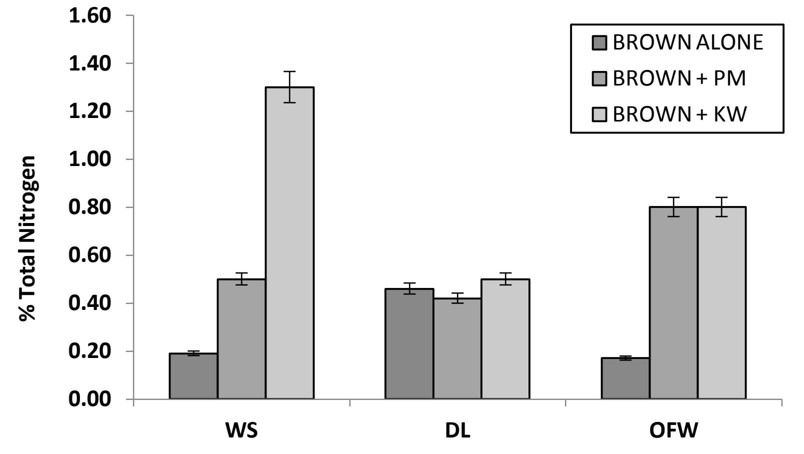

Fig.3: Total Nitrogen of composts Produced

The WS and OFW, because of their high carbon contents had C:N ration 28.7 and 25.5 respectively(Fig. 4). These figures are much higher than the normal range of C:N ratio for organic materials (8.1-12.1). Composting WS with PM or KW reduced its C:N ratio from 28.7 to 10.7 and 4.4 respectively. While composting OFW with PM or KW reduced its C:N ratio from 25.5 to 5.26 and 5.46 respectively. However, composting DL with either of the greens (PM or KW) did not affect its C:N ratio. This suggests that both PM and KW can effectively be used to enhance mineralization in WS and OFW when composted with them; due to increased microbial activity (Brown and Cotton, 2011).

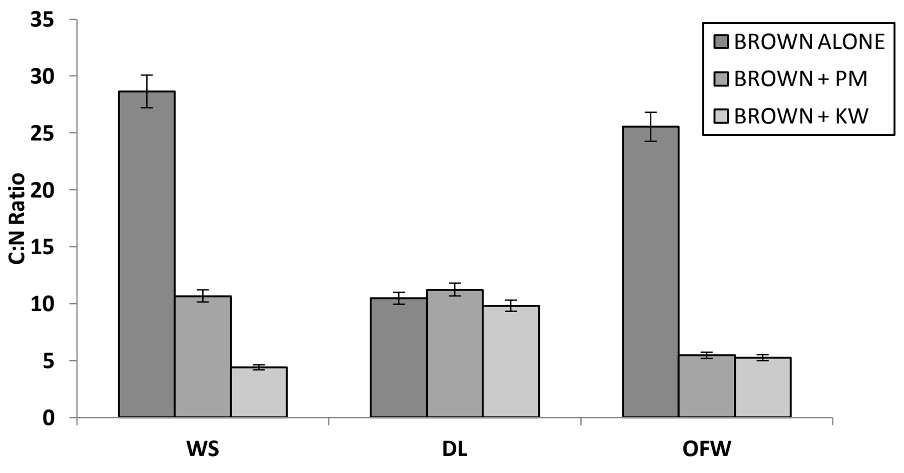

Fig.4: C:N Ratio of Composts Produced

IV. Conclusion

All the sources of 'browns' and 'greens' used have shown, that they can be successfully used as composting materials.Composting wood shavings and office wastes with either kitchen waste or poultry manure will produce quality composts with improved levels of pH, percentage organic matter contents, total nitrogen contents and better C:N ratio. The dry leaves can also be composted with either kitchen wastes and poultry manure, however, the quality of compost produced will be lower than those produced with wood shavings and office wastes; as browns.

Findings of this research have shown that composting with kitchen wastes as 'green' will increase percentage total nitrogen by as much as over 500%; as its high nitrogen content will enhance mineralization.

Composting these materials will not only improve the nutrient status of the soil but also enhance better waste management, carbon sequestration and healthy environment.

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