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Comparative Effect of Decomposed Organic Matter on Seedling Growth of *Pterocarpus erinaceus* Poir. (*Fabaceae*)

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Authors' contributions

This work was carried out in collaboration between both authors. Author AOO designed the study, performed the statistical analysis and wrote the manuscript. Author TOI managed the analyses of the study and managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

African kino tree *(Pterocarpus erinaceus)* plants are widely used species in afforestation programs but germination of seed and rate of seedling growth are major drawback. This study was therefore carried out to compare the effect of decomposed organic matter on the seedling growth rate of *Pterocarpus erinaceus.* The experiment was conducted in the screen house of Forestry Research Institute of Nigeria for a period of six months**.** Seedlings of *P. erinaceus* were subjected to four treatments. Decomposed kitchen waste (KW), decomposed fruit waste (FrW), decomposed fish waste (FW) and decomposed White leadtree (*Leucaena leucocephala* (LL)) leaves and control (CN). The experiment was laid out using a Completely Randomized Design. Each treatment was replicated seven times. Results showed that there was significant difference (P≤0.05) among the height of *P. erinaceus* seedlings subjected to different fertilizer applications. The mean seedlings height ranged from 11.55 to 18.34 cm with the highest mean height from seedlings subjected to LL while seedlings without fertilizer application had the least mean height. There was no significant

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difference (P≤0.05) among the collar diameter of *P. erinaceus* seedlings subjected to different fertilizer applications. The mean seedlings collar diameter ranged from 1.27 to 1.94 mm with the highest mean collar diameter from seedlings subjected to FW while seedlings without fertilizer application (CN) had the least mean collar diameter. Results also indicated no significant difference (P≤0.05) among the number of leaves of *P. erinaceus* seedlings subjected to different fertilizer applications. The mean seedlings number of leaves ranged from 12 to 16 with the highest mean number of leaves from seedlings subjected to LL, KW and FW while seedlings without fertilizer application had the least mean number of leaves. It is recommended that application of decomposed organic matter for proper growth of *Pterocarpus erinaceus* seedlings should be encouraged and properly disseminated to farmers.

Keywords: Pterocarpus erinaceus; fertilizer; Leucaena leucocephala; organic matter; decomposition.

1. INTRODUCTION

The demand for *P. erinaceus* Poir. (Fabaceae), popularly known as African kino tree has grown significantly in recent years. It is a medium-sized, generally deciduous tree of about 12-15 m tall. *Pterocarpus erinaceus* is derived from the Greek words 'pteran' meaning a wing and, 'karpos' meaning' fruit. The leaves of *P. erinaceus* are 30 cm long and have about 10 – 15 alternate leaflets. The leaf measures 6 -11 cm long and 3 – 6 cm wide (Kyei, 2016). *Pterocarpus erinaceus* is believed to be found in open forest and wooded savannah which is native to Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Cote d'Ivoire, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Mali, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Togo [1]. *Pterocarpus erinaceus* has valuable uses as food, medicine, fodder, apiculture, fuel, timber, gum or resin, tannin or dyestuff which makes it a good species for more scientific research findings. Because of its great potential in providing different products and services, it has gained so much attention subjecting the species to overexploitation in the country.

The growth of *P. erinaceus* tends to be stunted on poor soils, thus the need to replenish the soil for adequate plant productivity is necessary. There has been various studies conducted on the effect of compost on soil and plant growth. Duong [2], reported that the addition of compost increases soil nutrient availability thereby increasing nutrient uptake by plants directly and/or indirectly. Soil amended with organic fertilizer improves its physical properties (infiltration rate, water-holding capacity, and bulk density) and increases biological activity (respiration rate) more than the inorganic commercial fertilizers [3]. Organic municipal waste and other organic material such as manure can be composted. Composting is an aerobic process during which the organic matter is decomposed to humus-like substance (Duong, 2013), which is considered an economic and environmentally friendly way of reducing waste going into the landfill. The use of organic composts has long been recognized in agriculture to enhance growth and yield performance of plants while maintaining good soil environment. In a typical household, organic materials make up approximately one-third of household waste. Much of these organic materials can be properly handled and used for composting application. For decomposition process there is absolute need for the addition of soil to compost materials. The by-products of fish have been commonly used as fertilizers for the production of plants. Lema and Degebassa [4] reported that the use of dried protein obtained from processed fish (fish meal) was successfully used as a soil amendment in vegetable production systems. Fish waste manure are excellent sources of nutrition for soil and plant because fish waste contains a wide range of nutrients found in the planets' water. Application of organic materials such as animal manure, green manure, plant residue and composted organic matter have been reported to produce high yield and quality food crops [5]. Based on the benefit derived from using organic compost, producing a compost as organic fertilizer with higher nutrient content would be quite promising not only in providing greater stability in production, but also in maintaining better soil.

This project was carried out with the objective of comparing the effect of decomposed material of kitchen waste, fruit waste, *Leucaena leucocephala* (Lam.) leaves and fish waste on the seedling growth of *Pterocarpus erinaceus*.

2. MATERIALS AND METHODS

2.1 Study Area

The experiment was set up at the screen house of the Department of Sustainable Forest Management, Forestry Research Institute of Nigeria (FRIN), Ibadan, Oyo State for a duration of six months. FRIN is located on the longitude 07023'18" N to 07023'43" N and latitude 03051'20" E to 03051'43" E. The mean annual rainfall is about 1548.9 mm, falling within approximately 90 days. The mean maximum temperature is 31.90 C, minimum 24.20 C while the mean daily relative humidity is about 71.9% (FRIN 2015).

2.2 Collection and Preparation of Sample

Processed seeds of *Pterocarpus erinaceus* were collected from the seed section of FRIN and were sown in germination tray containing river sand. For this study, four treatments were used which are: Fruit waste (FrW), Kitchen waste (KW), Fish waste (FW) and *Leucaena leucocephala* leaves (LL). Fruit waste used for compost are banana peels, orange peels and pineapple peels which were collected from fruit sellers at Bodija Market, Ibadan. Kitchen waste used are vegetable stalk, plantain peels, potato peels, crushed eggshells, collected at the FRIN canteen. Fish waste was collected from FRIN fish pond after the fishes have been evacuated. *L. leucocephala* leaves were collected from FRIN arboretum. The treatments were mixed with soil at ratio 2:1 (treatments:soil) and left for 6 weeks to properly decompose.

2.3 Soil and Chemical Analysis

After 6 weeks, the decomposed materials were taken to FRIN soil laboratory for analysis. Nitrogen was determined using the Kjeldahl digestion, bray's method to determine phosphorus and Ammonium acetate extraction method to determine potassium.

2.4 Experimental Design and Treatments

The experiment was laid out in a Completely Randomized Design (CRD). The experiment had four (4) treatments which are; 2 kg of soil with decomposed kitchen waste (KW), 2 kg of soil with decomposed fruit waste(FrW), 2 kg of soil and air dried fish waste (FW), 2kg of soil with decomposed *L. leucocephala* leaves (LL) and the control (CN) (topsoil only). The experiment was replicated seven (7) times. Four weeks after planting, thirty five (35) seedlings of *Pterocarpus erinaceus* with two leaves were transplanted from the germination tray and planted in polythene pots (24 x 22 cm) containing each treatment and also in control (topsoil only). Parameters taken were plant height, collar diameter and number of leaves.

3. RESULTS

Result from Table 1 shows that *L. leucocephala* had the highest concentration of Nitrogen with 3.86%, where nitrogen is known to stimulate root growth and seedling development. Result also reveals that *L. leucocephala* had the highest concentration of Potassium. Fish waste showed the highest concentration of Phosphorus to be 20.9 mg/kg.

Analysis of Variance (ANOVA) indicated significant difference ($P \leq 0.05$) among the height, collar diameter and number of leaves of *Pterocarpus erinaceus* seedlings subjected to different fertilizer application (Table 2).

3.1 Seedling Height (cm)

The mean seedlings height ranges from 11.55 to 18.34 cm with the highest mean height from seedlings subjected to *L. leucocephala* while seedlings without fertilizer application had the least mean height (Table 3). Mean separation result revealed that height of seedlings subjected to *L. leucocephala*, kitchen waste and fish waste were not significantly different from each other, height of seedlings subjected to kitchen waste, fish waste and fruit waste were not significantly different from each other while height of seedlings without fertilizer application were significantly different from other height of seedlings subjected to other treatments (Table 3).

3.2 Seedling Collar Diameter (mm)

The mean seedlings collar diameter ranges from 1.27 to 1.97 mm with the highest mean collar diameter from seedlings subjected to Fish waste while seedlings without fertilizer application had the least mean collar diameter (Table 3). Mean separation result revealed that collar diameter of seedlings subjected to *L. leucocephala*, kitchen waste, fish waste and fruit waste were not significantly different from each other but were significantly different from collar diameter of seedlings without fertilizer application (Table 3).

Table 1. Chemical analysis of soil and compost

Parameters	Soil	Fruit waste	Kitchen waste	Fish waste	*L. leucocephala*
Nitrogen (%)	0.12	0.08	0.67	0.14	3.86
Phosphorus (mg/kg)	0.70	1.18	0.05	20.9	0.08
Potassium (cmol/kg)	0.05	0.10	0.11	0.06	1.20

Table 2. ANOVA result for the effect of compost application on the growth of *Pterocarpus erinaceus* seedlings

Parameters		df	SS	MS	F	Sig.
Height (cm)	Treatment	4	137.91	34.48	12.43	0.00*
	Error	20	55.48	2.77		
	Total	24	193.39			
Collar diameter (mm)	Treatment	4	1.53	0.38	13.24	0.00*
	Error	20	0.58	0.03		
	Total	24	2.10			
Number of leaves	Treatment	4	62.95	15.74	12.54	0.00*
	Error	20	25.10	1.26		
	Total	24	88.04			

**- significant (p<0.05)*

Keys: df = degrees of freedom, SS = Sum of squares, MS = Mean squares, F = F ratio

Table 3. Effect of fertilizer application on the height, collar diameter and number of leaves of *Pterocarpus erinaceus* seedlings

Treatment	Height (cm)	Collar diameter (mm)	Number of leaves
L. leucocephala	18.34±0.86^{a}	1.86±0.08^{a}	16±0.49^{a}
Kitchen waste	17.28±0.49^{ab}	1.88±0.08^{a}	16±0.68^{a}
Fish waste	16.80±0.62^{ab}	1.94±0.10^{a}	16±0.42^{a}
Fruit waste	15.85±1.16^{b}	1.86±0.07^{a}	15±0.48^{a}
Control	11.55±0.22^{c}	1.27±0.04^{b}	12±0.39^{b}

Mean ± standard error in parenthesis. Values sharing the same alphabet in the column are not significantly different (p≤0.05) using Duncan Multiple Range Test

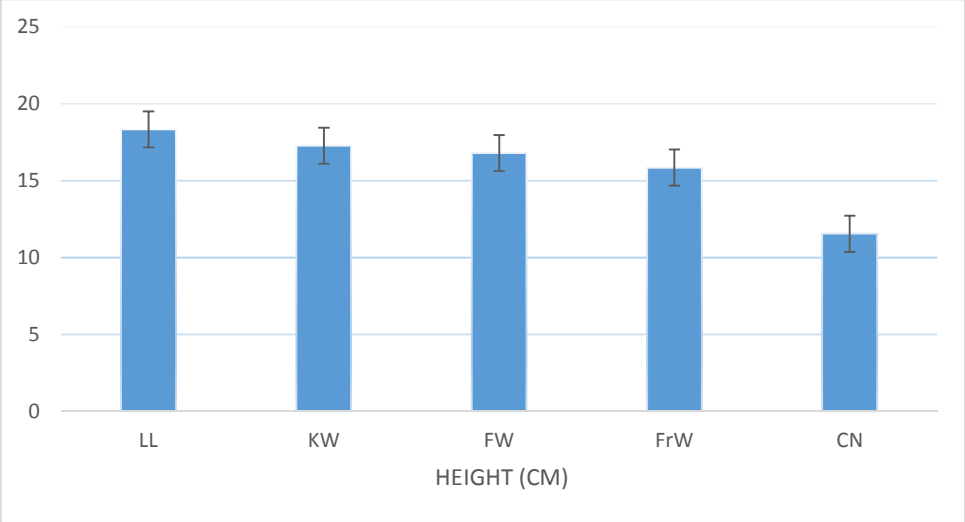

Fig. 1. Seedling height of *Pterocarpus erinaceus* subjected to different treatments

Keys: LL = Leucaena leucocephala, KW = Kitchen waste, FW = Fish waste, FrW = Fruit waste, CN = Control

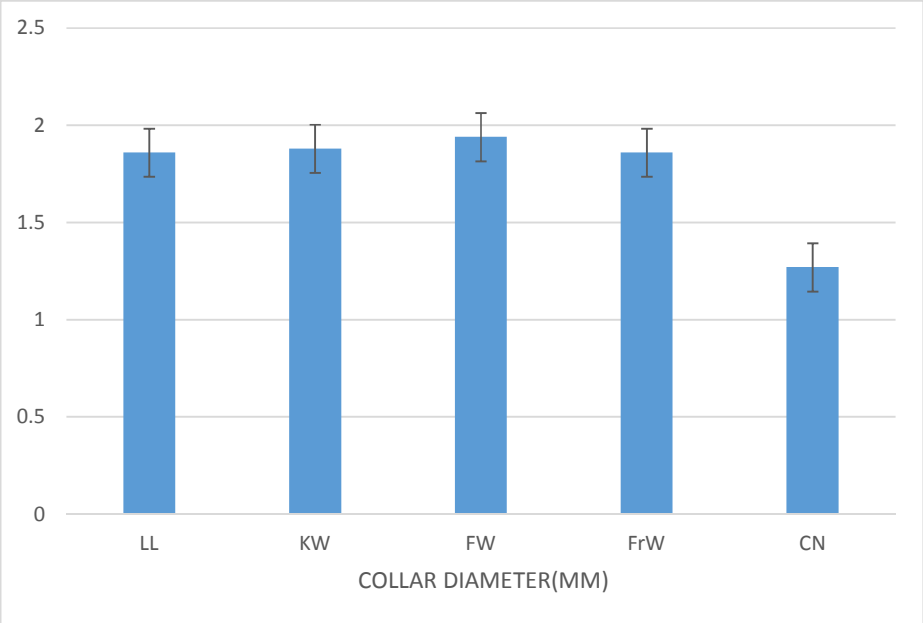

Fig. 2. Seedling collar diameter of *Pterocarpus erinaceus* subjected to different treatments
Keys: LL= Leucaena leucocephala, KW = Kitchen waste, FW = Fish waste, FrW = Fruit waste, CN = Control

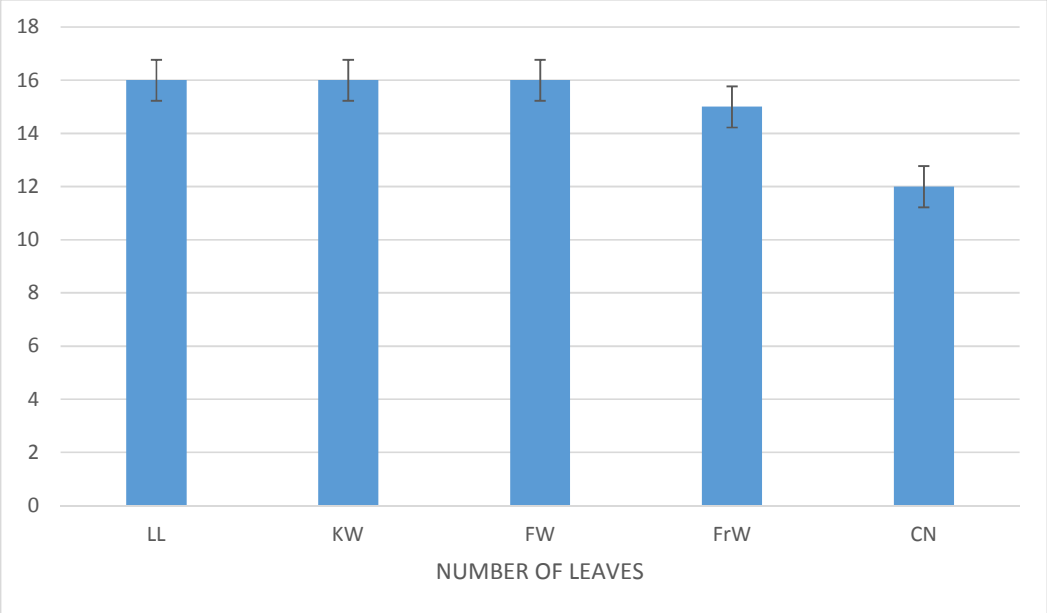

Fig. 3. Number of leaves of *Pterocarpus erinaceus* seedling subjected to different treatments
Keys: LL= Leucaena leucocephala, KW = Kitchen waste, FW = Fish waste, FrW = Fruit waste, CN = Control

3.3 Seedling Number of Leaves

The mean seedlings number of leaves ranges from 12 to 16 with the highest mean number of leaves from seedlings subjected to *L. leucocephala*, kitchen waste and fish waste while seedlings without fertilizer application had the least mean number of leaves (Table 3). Mean separation result revealed that number of leaves of seedlings subjected to *L. leucocephala*, kitchen waste, fish waste and fruit waste were not significantly different from each other but

were significantly different from the number of leaves of seedlings without fertilizer application (Table 3).

4. DISCUSSION AND CONCLUSION

Result from chemical analysis (Table 1) shows that the decomposed organic materials released more nutrient to the soil which improved the growth performance of *Pterocarpus erinaceus.* Duong [2] reported that the addition of compost increased available N in clay soils compared to the unamended soil with a stronger effect from garden waste compost. Duong [2] also reported that both garden waste and agriculture residues and manures increased wheat growth and shoot P concentrations with the effect of agricultural residues and manures being greater than that of garden waste. Compost can stimulate plant growth, root development and increase the nutrient available for plant's uptake [6,7]. Louisa and Taguiling [3] reported that the use of green biomass-enriched crop residue compost significantly which stimulated plant growth in terms of plant height, number of leaves, size of leaves, number of buds, and total weight of fresh plant biomass which is in correlation with the results obtained from this experiment. The height of *P. erinaceus* varied significantly among the different compost (Table 2). *L. leucocephala* had the highest mean height of 18.34 while control had the lowest mean height of 11.55. Kitchen waste, fish waste and fruit waste had the mean height of 17.28, 16.80 and 15.85 respectively. The result showed that there was no significant difference in mean height of seedlings subjected to *L. leucocephala*, kitchen waste and fish waste. However, *L. leucocephala* produced the highest nitrogen level (Table 1) which is the most important plant nutrient required for plant growth. Nitrogen is an essential component of chlorophyll, enzymes, proteins, etc. which occupies a unique position as a plant nutrient because rather high amounts are required compared to the other essential nutrients [8]. The mean collar diameter were not significantly different from each other but was significantly different from the control. Fish waste had the highest mean collar diameter of 1.94mm while control had the lowest mean collar diameter of 1.27 mm. Kitchen waste had a mean collar diameter of 1.88 mm while *L. leucocephala* and fruit waste both had 1.86 mm. Lema and Degebassa [4], reported that tomato fertilized with fish offal's fertilizer grew better than those fertilized with chemical fertilizer at later stages and concluded that their result is in agreement with those obtained by Irshad and Javed [9], where the high yield of Mung bean and Okra were obtained from plants treated with fish fertilizers as compared to Nitrogen-Phosphorous-Potassium (NPK) and Urea fertilizer. This supports the findings of this experiment that the addition of fish waste compost to soil increased the growth performance of *Pterocarpus erinaceus* seedlings. Fish waste is a good soil conditioner that allows proper development of leaves and branches. Number of leaves of seedlings subjected to kitchen waste, *L. leucocephala,* fruit waste and fish waste were not significantly different and this clearly shows that the productivity of *Pterocarpus erinaceus* is significantly higher when either of the decomposed materials is used as organic fertilizer. This is in correlation with findings of Ogunsiji et al., [10] who reported that addition of decomposed leaves of *Gliricidia sepium* to soil performed best in improving the growth of *Parkia biglobosa* seedlings.

In conclusion, the experiment reveals that the decomposition of *Leucaena leucocephala*, fish waste, fruit waste and kitchen waste after 6weeks of decomposition added more essential nutrient to the soil which is necessary for the growth and development of *Pterocarpus erinaceus* seedlings at the nursery stage before they are transferred to the plantation. Thus, such is recommended to farmers in replacement of inorganic fertilizer for the production of *Pterocarpus erinaceus* seedlings.

CONTRIBUTION TO KNOWLEDGE

This study provides plantation establishers and farmers with specifications on how compost can be used in place of inorganic fertilizers for soil nourishment and plant development. Adopting this method is cheap and environmentally friendly, thus highly recommended. The study will help researchers understand the practical aspect about the production of compost and will be a guide to discovering other materials that can be used in producing a quality compost.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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