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SAWDUST AND RICE HUSK BIOCOMPOSTS: COMPARATIVE EFFECTS ON SOIL PROPERTIES AND GROWTH OF FLUTED PUMPKIN (*Telfairia occidentalis*)

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ABSTRACT

Organic farming is gaining renewed attention as sustainable and cost-effective alternative to synthetic fertilizer. This study evaluated the impact of sawdust and rice husk biocomposts on soil physicochemical dynamics, and growth performance of Fluted pumpkin (Telfairia occidentalis). Samples of raw sawdust and rice husks were heaped with unrefined crude sugar (Gur) as carbon starter, and wheat bran (choker) as nutritional accelerator, and moisturized for 3-4 days. The components were mixed with gypsum and re-piled for 10-12 days. The resulting biocomposts were air-dried and subjected to chemical profiling using standard laboratory procedures. The Fluted Pumpkin seeds were sown in the soils amended with 500 g of the biocomposts, and the unamended soil as the Control. The results showed significantly higher Nitrogen ($p < 0.001$), Sodium ($p = 0.001$), Potassium ($p < 0.001$), Zinc ($p < 0.001$) and Copper ($p < 0.001$) in the sawdust compost than the rice husk; while Magnesium, Phosphorus and Iron were higher in the rice husk ($p < 0.05$). Furthermore, the amended soils were observed to have higher mineral nutrients than the unammended soil with a significant rise in Cation Exchange Capacity and Electrical Conductivity ($p < 0.05$). On the growth performance of T. occidentalis, rice husk compost produced significantly longer vines and more tendrils, while the sawdust promoted vegetative yield and biomass weight ($p < 0.05$). The biocomposts produced in this study significantly improved soil properties and the growth responses of T. occidentalis confirming their value as sustainable pathways for waste-to-wealth agricultural systems.

Keywords: Organic Amendment, Cation Exchange Capacity, Lignocellulosic Waste Valorization, Priming Effect

Introduction

Agricultural productivity in many developing countries is severely constrained by the challenges of soil degradation, high input costs, and environmental instability (Adekiya *et al.,* 2021). In response, organic farming practices, particularly the utilization of biocompost, have gained renewed attention as a sustainable, cost-effective paradigm to enhance crop yield while maintaining long-term soil health (Adekiya *et al*., 2021). Biocompost is a form of organic fertilizer that is derived from the decomposition of organic waste materials such as agricultural residues, kitchen waste, and animal manure (Benyahya *et al.,* 2021). This controlled process transforms raw, unstable wastes into a nutrient-rich soil amendment capable of modifying soil aggregation, enhancing moisture retention capacity, and stimulating the proliferation of indigenous microbial community (Benyahya *et al*., 2021). Biocompost offers multifaceted agro-ecological benefits as compared to synthetic fertilizer. It is eco-friendly, recycles localized organic wastes to combat pollution, optimizes bulk density, and significantly accelerates soil enzymatic and microbial dynamics (Joshi *et al*., 2019; Ofori *et al*., 2022; Okon *et al*., 2019). Aderi *et al*. (2011) also observed that while the mineralization and subsequent release of nutrients from organic matrices occur at a slower rate, they exert a more sustained, long-term effect on soil fertility than the synthetic fertilizers which are often lost rapidly by leaching in porous soil and heavy rainfall areas.

Recent investigations have demonstrated that composts synthesized from lignocellulosic agro-industrial by-products, such as rice husks and sawdust, can effectively satisfy plant nutritional requirements by yielding vital macronutrients, essential trace elements, and humic substances necessary for robust plant development (Akubude *et al.,* 2023; Kalu *et al.,* 2021). Fortunately, these materials are abundant, biodegradable, and rich in organic carbon and nitrogen, making them ideal candidates for composting. Furthermore, converting these processing wastes into agricultural inputs reduces dependence on chemical fertilizers, and mitigates open burning and landfill accumulation, thereby minimizing regional greenhouse gas emissions and localized soil and environmental toxicity over time (Nwaka *et al.,* 2022).

Fluted pumpkin (*Telfairia occidentalis* Hook. F.), also known as "Ugu" in Nigeria, is an important leafy vegetable crop widely cultivated in West Africa (Alegbejo, 2012). Morphological and botanical records indicate that the species originated in West Africa and widely distributed in the forest zone of west and central Africa, especially in Benin, Nigeria and Cameroun (Umekwe *et al.,* 2020). In Nigeria, it is among the most economically and nutritionally important vegetables widely cultivated for its high protein, vitamin, and mineral contents (Adekiya *et al.,* 2020). Due to its dietary importance, urban demand consistently outstrips current farm outputs, resulting in severe seasonal market scarcities and increased consumer pricing (Okporie *et al*., 2012). However, the productivity of fluted pumpkin has been remarkably limited by factors such as poor native soil fertility and nutrient deficiencies (Okporie *et al*., 2012). There is therefore a growing need to enhance its production through sustainable agronomic inputs.

While previous literatures outline the general utility of organic amendments, there remains a distinct research gap regarding how the distinct elemental configurations of sawdust and rice husk biocomposts uniquely modify the chemical architecture of amended soils specifically regarding Cation Exchange Capacity (CEC), dynamic shifts in Organic Matter (OM), and ionic availability. Moreover, there is paucity of comparative data directly correlating the raw nutrient profile of these specific lignocellulosic composts to the explicit morphological responses of *T. occidentalis*. Therefore, this study investigated the comparative mineral and physicochemical composition of sawdust and rice husk biocomposts, evaluating their subsequent influence on soil nutrient dynamics and the morphological performance of *T. occidentalis*.

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Materials and Methods

1 Study Area

The field layout and greenhouse components of this study were conducted at the experimental farm plot within the Rev. Fr. Moses Orshio Adasu University (formerly Benue State University) in Makurdi metropolis, Benue State, Nigeria. Makurdi town is located between latitude 6^0 25'N and 8^0 8'N of the equator and longitude 7^0 45'E and 10^0 0'E of the Greenwich Meridian. It shares boundaries with Guma Local Government North East, Gwer to the South, Gwer-West to the West and Doma Local Government Area of Nasarawa State to the North-West. It falls within the tropical humid and mega thermal climate. The climate is characterized by wet and dry seasons. The wet season lasts from April to October while the dry season starts in November and ends in March. This variation in season has effect on vegetation (Abah, 2012).

2 Site Preparation

A spot was prepared at the experimental farm plot where planting took place. Fertile loamy topsoil was collected from different locations in Rev. Fr. Moses Orshio Adasu University, Makurdi and poured on a flat surface to sun dry for two days. Planting containers were bought from a horticulturist into which the dried soil samples were poured (Odiaka *et al.,* 2008).

3 Collection and Preparation of Organic Substrates

Samples of rice husk and sawdust residues were sourced from Wurukum Rice Processing Mill, and Makurdi Timber Shade, along Naka road respectively. The residues were initially moisturized for 3-4 days and stacked in windrows with local microbial activation ingredients such as unrefined crude brown sugar (gur) which served as an immediate labile carbon energy source, and wheat bran coarse flakes (choker), acting as a protein-rich nitrogen accelerator. These matrices were thoroughly mixed with structural gypsum ($CaSO_4.2H_2O$) and re-piled for 10-12 days. The moisture content of the piles was consistently maintained at approximately 60 % to 65 % by wetting periodically. Manual turning was executed weekly to maintain non-limiting oxygen diffusion rates and prevent anaerobic core formation (Pratap and Prabha, 2017; Benyahya *et al*., 2021). At maturity, the resulting biocomposts were air-dried, crushed, and passed through a 2 mm mesh sieve prior to laboratory profiling and soil incorporation (Akubude *et al*., 2023).

4 Experimental Design and Field Layout

This study was laid out in a Randomized Complete Block Design (RCBD) containing three treatments replicated in triplicate blocks as follows:

1. Native soil amended with 500 g of Sawdust Biocompost (SD) per experimental planting container.
2. Native soil amended with 500 g of Rice Husk Biocompost (RH) per experimental planting container.
3. Control (CT) containing untreated native soil with zero organic amendments

5 Seed Collection, Planting and Manure Application

The seeds of pumpkin *Telfairia occidentalis* (Ugu) were bought at High- Level market, Makurdi and subjected to viability testing via water flotation method. The seeds were planted two per hole in planting Containers containing soil sample at the depth of 3 to 4cm (Odiaka *et al.,* 2008). The synthesized biocomposts were applied two weeks before planting to enable proper decomposition and release of nutrients (Umekwe *et al.,* 2020). Weeding was done 3 weeks after planting and subsequently as the need arose, while staking was done at 3 weeks after planting up to 8 weeks. Manual irrigation was uniformly maintained across all experimental units.

6 Chemical Profiling of Biocomposts and Experimental Soil

Samples of the synthesized sawdust and rice husk biocomposts, as well as the composite soil collected at a depth of 0 – 20 cm prior to treatment incorporation (baseline) and immediately post-harvest, were subjected to chemical profiling in duplicates. Total Nitrogen (N) was quantified using the micro-Kjeldahl digestion and distillation procedure as described by standard analytical protocols (Aderi *et al*., 2011). Phosphorus (P) was extracted using the Bray-1 extraction solution and sequentially measured via spectrophotometry at a wavelength of 660 nm (Adekiya *et al*., 2021). Exchangeable Cations (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}) were displaced from the exchange complex using a neutral 1M ammonium acetate (NH_4 OAc) solution. Potassium and Sodium concentrations were determined via flame photometry, while Calcium and Magnesium were quantified using atomic absorption spectrophotometry (AAS). Cation Exchange Capacity (CEC) was determined via the ammonium distillation method following the displacement of index ions (Benyahya *et al*., 2021). Total Organic Carbon (C) and Organic Matter (OM) were analysed using the Walkley-Black wet chromic acid oxidation method, with the organic matter fraction calculated by multiplying the total organic carbon percentage by the standard Van Bemmelen factor of 1.724 (Joshi *et al*., 2019). pH and Electrical Conductivity (EC) were measured electronically in a 1:2.5 soil-to-water suspension using a calibrated digital pH meter and a conductivity bridge, respectively (Ofori *et al*., 2022). Lead (Pb) was digested using a triple-acid mixture (HNO_3-$HClO_4$-H_2SO_4) and analysed using an atomic absorption spectrophotometer to ensure bio-safety thresholds (Nwaka *et al*., 2022).

7 Data Collection

The following parameters were collected in this study: vine length, number of leaves, number of tendrils, stem girth, number of branches and marketable leaf yield by weight. These vegetative development parameters were measured bi-weekly at Weeks 2, 4, 6, and 8 post-planting using the method described by (Umekwe *et al*., 2020) as follows:

Vine Length: Measured from the soil surface line to the primary apical meristem tip using a flexible metric measuring tape.

Number of Leaves and Branches: Quantified by direct visual counting of fully expanded foliar units and active primary lateral vegetative branches.

Stem Girth: Determined at a fixed point 5 cm above the soil line using a digital vernier caliper.

Number of Tendrils: Tracked by direct enumeration of individual coiled structural appendages per plant canopy.

Fresh Leaf Weight: Evaluated at the final harvest phase (Week 8) by detaching fully expanded leaves from the primary vine architecture and weighing them immediately on a high-precision digital analytical balance to prevent desiccation-induced mass errors.

8 Data Analysis

The data collected was computed on SPSS (Statistical Package for Social Sciences) version 20.0. The laboratory analytical data for the biocompost substrates were subjected to an independent-sample T-test to evaluate significant variations between the two lignocellulosic materials. The soil chemistry modifications and the multi-week vegetative performance data on the other hand were subjected to a one-way Analysis of Variance (ANOVA). Treatment means were separated and compared using Fisher's Least Significant Difference (FLSD) test, with all statistical decisions evaluated at a confidence threshold of $p < 0.05$

Result

1 Mineral Composition of Lignocellulosic Biocomposts Synthesized from Sawdust and Rice Husk

Table 1 shows the mineral composition of lignocellulosic biocomposts produced from sawdust and rice husks. The comparative analysis showed that the compost from Sawdust had significantly higher concentration of Nitrogen ($T = 220.617$; $p < 0.001$), Sodium ($T = 40.498$; $p = 0.001$), Potassium ($T = 791.960$; $p < 0.001$), Zinc ($T = 235.682$; $p < 0.001$), and Copper ($T = 156.849$; $p < 0.001$) compared to the rice husk-based biocompost. On the other hand, the concentration of Magnesium (T = 26.333; $p = 0.001$), Phosphorus (T = 65.000; $p < 0.001$), and Iron (T = 72.000; $p < 0.001$) was higher in the Compost from rice husk. No significant difference in Lead concentration was however observed (T = 2.000; $p = 0.184$).

Table 1: Mineral Composition of Biocompost from Saw Dust and Rice Husk

Mineral Element	Concentration in Biocompost		T-Value	P-Value
	Saw Dust	Rice Husk		
Nitrogen (%)	3.58±0.01	2.02±0.01	220.617	$p < 0.001$
Phosphorus (mg/100g)	0.08±0.00	0.73±0.01	65.000	$p < 0.001$
Magnesium (mg/100g)	1.16±0.02	1.56±0.00	26.333	$p = 0.001$
Sodium (mg/100g)	3.75±0.07	1.72±0.01	40.498	$p = 0.001$
Potassium (mg/100g)	6.62±0.01	1.02±0.01	791.960	$p < 0.001$
Iron (mg/100g)	0.350±0.01	1.07±0.00	72.000	$p < 0.001$
Zinc (mg/100g)	4.22±0.01	1.59±0.01	235.682	$p < 0.001$
Manganese (mg/100g)	4.26±0.01	1.33±0.02	162.805	$p < 0.001$
Lead (mg/100g)	0.009±0.001	0.007±0.000	2.000	$p = 0.184$
Copper (mg/100g)	3.46±0.02	0.98±0.01	156.849	$p < 0.001$

*Values are Mean ± Standard deviation in duplicates. For each mineral component, P-values that are less than 0.05 (p <0.05) are considered statistically significant.

2 Comparative Effect of Biocomposts Synthesized from Sawdust and Rice husk on the Mineral and Physiochemical Properties of the Soil

The comparative effect of sawdust biocompost on the mineral and physiochemical properties of the soil is presented in Table 2. The result shows that the soil sample amended with the biocompost showed significantly higher Cation Exchange Capacity (CEC), Electrical Conductivity (EC), pH, Carbon, Nitrogen and Phosphorus than the unamended soil ($p < 0.05$). The organic matter and Potassium on the other hand were observed to be higher in the unamended soil compared to the soil amended with the biocompost ($p < 0.05$).

The result further showed that the soil amended with the sawdust-based Compost was higher in all mineral components and physicochemical parameters except organic matter and electrical conductivity, than the Compost from rice husk ($p < 0.05$). While the organic matter was significantly higher in the rice husk Compost ($p < 0.05$). No significant difference in electrical conductivity was observed between them ($p > 0.05$).

Table 2: Comparative Effect of Sawdust Biocompost on the Mineral and Physiochemical Properties of the Soil

Physicochemical Properties	Unamended Soil	Biocompost Amended Soil		Sig.
		Sawdust	Rice Husk	
Cation Exchange Capacity (CEC)	$57.64±0.01^a$	$79.17±0.00^b$	$63.79±0.00^c$	$p < 0.001$
Organic Matter	$0.919±0.002^d$	$0.662±0.00^e$	$0.881±0.02^d$	$p < 0.001$
Carbon (C)	$8.21±0.00^f$	$33.65±0.17^g$	$10.50±0.25^h$	$p < 0.001$
Nitrogen (N)	$0.52±0.01^i$	$2.33±0.02^j$	$2.02±0.03^k$	$p < 0.001$
Phosphorus (P)	$0.07±0.02^l$	$0.36±0.01^m$	$0.20±0.00^n$	$p < 0.001$
Potassium (K)	$0.24±0.01^p$	$0.45±0.00^q$	$0.17±0.00^p$	$p = 0.001$
pH	$6.82±0.05^r$	$6.67±0.01^s$	$6.45±0.01^t$	$p = 0.003$
Electrical Conductivity (EC)	$0.36±0.01^u$	$36.55±0.02^v$	$38.50±1.98^v$	$p < 0.001$

*Values are Mean ± Standard deviation in duplicates. Mean values with similar superscripts in a row are not significant.

3 Comparative Potential of Biocompost from Saw Dust and Rice Husk in Evaluating Number of Branches

Table 3 shows the comparative potential of biocomposts from saw dust and rice husk in the evaluation of the number of branches of fluted pumpkin. The result showed an increase in the number of branches from week 2 – 8 in all the treatments. At week 8, there was a slightly higher number of branches in the saw dust treatment compared to the rice husk however, no significant difference was observed ($p > 0.05$). Both treatments however showed significant difference when compared with the Control ($p < 0.05$).

Table 3: Comparative Potential of Biocomposts from Saw Dust and Rice Husk in the Determination of the Number of Branches of Fluted Pumpkin

	Number of branches			
Treatment	**Week 2**	**Week 4**	**Week 6**	**Week 8**
Saw dust	14.00 ± 1.00^{a}	20.66 ± 1.15^{b}	25.00 ± 0.00^{c}	32.33 ± 2.52^{d}
Rice husk	13.67 ± 0.58^{a}	20.00 ± 2.65^{b}	24.00 ± 4.58^{c}	31.33 ± 7.09^{d}
Control	12.00 ± 2.00^{a}	15.00 ± 1.00^{f}	17.00 ± 1.00^{g}	22.33 ± 2.52^{e}

*Values are mean ± standard deviation in triplicates. Mean values with similar superscripts in a column are not significant.

4 Comparative Potential of Biocompost from Saw Dust and Rice Husk in Evaluating Number of Leaves

Table 4 shows the comparative potential of biocomposts from saw dust and rice husk in the evaluation of the number of leaves. It was observed that at Week 8, the plants in the rice husks treatment had slightly higher number of leaves (71.67 ± 7.64) than those in the saw dust (66.67 ± 5.77). There was however no significant difference observed between them ($p > 0.05$). The result further showed that both treatments had significantly more number of leaves than the Control treatments ($p < 0.05$).

Table 4: Comparative Potential of Biocompost from Saw Dust and Rice Husk in the Determination of the Number of Leaves

	Number of Leaves			
Treatment	**Week 2**	**Week 4**	**Week 6**	**Week 8**
Saw dust	40.33 ± 2.52^{e}	56.33 ± 0.58^{h}	60.00 ± 1.00^{a}	66.67 ± 5.77^{c}
Rice husk	34.67 ± 2.52^{f}	51.00 ± 4.58^{i}	56.67 ± 5.77^{a}	71.67 ± 7.63^{c}
Control	11.00 ± 1.00^{g}	10.33 ± 0.58^{j}	23.67 ± 3.21^{b}	32.33 ± 4.04^{d}

*Values are mean ± standard deviation in triplicates. Mean values with similar superscripts in a column are not significant

3.5 Comparative Potential of Biocompost from Saw Dust and Rice Husk in Evaluation of Vine Length of Fluted Pumpkin

Table 5 shows the comparative potential of the biocompost of saw dust and rice husk in the evaluation of the vine length of fluted pumpkin. The result showed that fluted pumpkin plants in the rice husk treatment had significantly longer vine (107.67 ± 8.74 cm) than those in the saw dust (90.00 ± 5.00 cm), and other treatments ($p < 0.05$). Those in the rice husk also had significantly longer length than those in the Control (28.67 ± 5.51 cm) ($p < 0.05$).

Table 5: The comparative Potential of Saw Dust and Rice Husk Biocomposts in the Evaluation of the Vine Length of Pumpkin

	Vine length (cm)			
Treatment	**Week 2**	**Week 4**	**Week 6**	**Week 8**
Saw dust	47.00 ± 6.06^{a}	79.00 ± 1.00^{d}	83.33 ± 2.89^{g}	90.00 ± 5.00^{i}
Rice husk	52.50 ± 2.00^{c}	99.00 ± 8.54^{e}	101.67 ± 7.64^{h}	107.67 ± 8.74^{j}
Control	20.33 ± 0.58^{b}	30.33 ± 0.58^{f}	21.67 ± 1.53^{d}	28.67 ± 5.57^{e}

*Values are mean ± standard deviation. Mean values with similar superscipts in a column are not significant

6 Comparative Potential of Saw Dust and Rice Husk Biocompost in Evaluation of Stem Girth

Table 6 shows the comparative potential of the saw dust and rice husk biocomposts in the evaluation of the stem girth of fluted pumpkin. The stem girth was higher in the plants in the saw dust treated group than those in rice husk treated group. Both treatments were not significantly different from each other, but both had significantly higher stem girth than the Control ($p < 0.05$).

Table 6: Comparative potential of saw dust and rice husk biocomposts in the evaluation of stem girth of fluted pumpkin

	Stem girth (cm)			
Treatment	**Week 2**	**Week 4**	**Week 6**	**Week 8**
Saw dust	3.33 ± 1.44^{a}	2.33 ± 0.289^{d}	2.17 ± 0.29^{e}	2.67 ± 0.29^{f}
Rice husk	3.00 ± 0.00^{a}	2.33 ± 0.40^{d}	2.83 ± 0.29^{i}	2.50 ± 0.50^{f}
Control	1.00 ± 0.00^{c}	1.00 ± 0.00^{h}	1.50 ± 0.00^{j}	1.50 ± 0.00^{g}

*Values are mean ± standard deviation in triplicates. Mean values with similar superscripts in a column are not significant.

7 Comparative Potential of Saw Dust and Rice Husk Biocomposts in Evaluation of Number of Tendrils

Table 7 shows the comparative potential of the saw dust and rice husk biocomposts in the evaluation of the number of tendrils of fluted pumpkin, the number of tendrils in the rice husk treatment was observed to be significantly higher than all the treatments ($p < 0.05$). This was followed by the saw dust treatment which was significantly higher than the control ($p < 0.05$).

Table 7: Comparative Potential of the Saw Dust and Rice Husk Biocomposts in the Evaluation of the Number of Tendrils of Fluted Pumpkin

	No of Tendrils			
Treatment	**Week 2**	**Week 4**	**Week 6**	**Week 8**
Saw dust	11.33 ± 1.53^{a}	14.00 ± 1.00^{d}	15.33 ± 1.53^{i}	18.33 ± 1.53^{e}
Rice husk	11.00 ± 1.73^{a}	17.33 ± 1.15^{g}	18.67 ± 1.15^{j}	23.00 ± 2.65^{f}
Control	6.50 ± 0.71^{b}	8.00 ± 1.00^{c}	10.33 ± 0.58^{d}	16.00 ± 1.00^{e}

*Values are Mean ± standard deviation in triplicates. Mean values with similar superscripts in a column are not significant.

8 Comparative Potential of Saw Dust and Rice Husk Biocompost in Evaluation of Leaf Weight.

Table 8 shows the comparative potential of the saw dust and rice husk biocomposts in the evaluation of leaf weight. The weight of pumpkin leaves was observed to be significantly higher in the saw dust treatment compared to the other treatments ($p < 0.05$)

Table 8: Comparative potential of the Saw dust and Rice husk composts in the evaluation of leaf

Treatment	**Leaf weight (g) at harvest**
Saw dust	0.50 ± 0.00^{b}
Rice husk	0.10 ± 0.00^{c}
Control	0.20 ± 0.10^{a}

*Values are Mean ± standard deviation in triplicates. Mean values with similar superscripts are not significant

Discussion

In this study, biocomposts synthesized from sawdust (SD) and rice husk (RH) showed highly distinct nutritional and structural profiles that are considered critical for their effectiveness in supporting the growth and yield of plants. The two composts were observed to possess dense macro nutritional components but with significant variation in their compositions particularly the total Nitrogen (N), which was substantially higher in the sawdust matrix compared to its rice husk counterpart. This high nitrogen concentration in sawdust compost can be attributed to the inherent chemical differences in their raw organic frameworks (Akubude *et al*., 2023; Kalu *et al*., 2021). The epidermal layer of raw rice husk is known to be rigid and highly silified. As such, the rapid microbial access to underlying cellular nitrogen during the initial thermophilic phase of composting is impeded, whereas the cell wall structure of specific tropical wood sawdowns are porous paving way for a more accelerated microbial colonization and subsequent nitrogen concentration via biomass turnover (Akubude *et al*., 2023; Kalu *et al*., 2021). The result on the other hand showed higher Magnesium (Mg) content in the rice husk biocompost compared to the sawdust variant. According to Benyahya *et al*. (2021), rice husks naturally accumulate high amounts of mineral ash, phytin and inorganic phosphates during plant growth, which are biologically concentrated and stabilized throughout the humification process. Furthermore, the micronutrient profile displayed a similar divergent pattern. Sawdust biocompost was strongly enriched with Zinc, Manganese and Copper while rice husk was highly superior in Iron and Copper contents. This divergent partitioning of trace elements indicates that none of the substrates is uniformly superior; rather, they present complementary nutritional architectures that can be selectively utilized based on specific soil deficiencies or target crop demands. Notably, both organic matrices exhibited safe, negligible threshold values for heavy metals such as Lead (Pb), validating the biological safety of using these localized agro-industrial by-products as raw materials for organic fertilizer production within urban and peri-urban smallholder farming clusters (Nwaka *et al*., 2022).

The impact of the application of the synthesized lignocellulosic biocomposts on the soil was also evaluated with the results showing profound and statistically significant transformation in the soil's chemical architecture. The Cation Exchange Capacity (CEC) of the soil increased significantly from the 57.64±0.01 cmol/kg baseline to an exceptional 79.17±0.00 cmol/kg in the sawdust and 63.79±0.00 cmol/kg in the rice husk amended soils. This increase in the soil's electrostatic surface charge density indicates that the humified organic matter from the biocomposts contributed an abundance of functional carboxyl and phenolic hydroxyl groups (Adekiya *et al*., 2021). These functional groups increase negative charge sites on soil colloids, fundamentally reconstructing the soil's buffering capacity and its ability to retain and exchange essential exchangeable cations such as Ca^{2+}, Mg^{2+}, K^{+} against leaching forces induced by intensive precipitation (Aderi *et al*., 2011). In this study, an interesting inverse relationship was observed in the Organic Matter (OM) dynamics, particularly within the sawdust-amended soil. A statistically significant drop from the baseline 0.919±0.002% to 0.662±0.000% was experienced even though the total organic Carbon (C) increased four-fold from 8.21±0.01% to 33.65±0.00% and total Nitrogen rose from 0.52±0.00% to 2.33±0.00%. This phenomenon shows profound soil Priming Effect or hyper-accelerated mineralization (Benyahya *et al*., 2021). The introduction of the sawdust compost which is a high nitrogenous organic matrix provided an immediate, easily accessible energy and nitrogen source for the indigenous soil microbial community. This prompted the proliferation of heterotrophic microbes, causing them to aggressively metabolize and mineralize both the added labile compost fractions and the recalcitrant native soil organic matter to fulfil their metabolic carbon demands (Joshi *et al*., 2019). The unprecedented increase observed in the Electrical Conductivity (EC) of the soil which leaped from a baseline of 0.36±0.00 µS/m to 36.55±0.00 µS/m in the sawdust group and 38.50±0.00 µdS/m in the rice husk group further validated this rapid mineralization observed. Such a massive increase in EC values serves as direct chemical evidence of rapid mineralization. The complex organic structures within the biocomposts were broken down rapidly, releasing a dense concentration of soluble inorganic ions and mineral salts into the soil solution, making them immediately bioavailable for plant root absorption (Ofori *et al*., 2022).

This study further assessed the potential of the biocomposts on the agronomic parameters of *Telfairia occidentalis* for a period of Eight (8) weeks. The composts showed high performance potential with their distinct chemical and elemental configurations translating into highly specific morphological growth patterns that outperformed the unammended soil across all measured metrics. This highlights the necessity of the use of organic amendments as a booster in nutrient-depleted tropical soils (Okporie *et al*., 2012).

Comparatively, the rice husk biocompost showed unique potential in enhancing vertical and structural development, producing significantly longer vines and a vastly superior number of tendrils by Week 8 compared to the sawdust and control treatments. This superior performance in phenotypic elongation can be directly linked to the high concentration of Phosphorus and Magnesium observed in the raw rice husk compost. According to Adekiya *et al*. (2020), Phosphorus is heavily involved in cellular energy transfer (ATP synthesis), root architecture development, and vascular cell division, which are vital for rapid vine elongation in climbing crops like *T. occidentalis*. Concurrently, Magnesium is a known key component of the chlorophyll ring which helps to maximize photosynthetic light-harvesting efficiency to fuel rapid structural growth and tendril generation (Umekwe *et al*., 2020). The sawdust biocompost on its part was observed to principally promote vegetative yield and biomass weight, generating a significantly higher individual leaf weight (0.50±0.00 g) at harvest compared to the rice husk group (0.10±0.00 g). This substantial accumulation of tissue mass may be attributed to the higher Nitrogen content (3.58±0.0 %) present in the sawdust compost which was mineralized and released steadily and heavily into the soil thereby driving thicker cell walls and denser leaf tissues (Adekiya *et al*., 2020). Nitrogen has been noted as the foundational building block for plant amino acids, structural proteins, and vegetative cell enlargement (Okon *et al*., 2019).

Conclusion

The application of lignocellulosic biocomposts from sawdust and rice husk offers a highly effective, low-cost, and ecologically sustainable strategy for restoring nutrient-depleted tropical soils and enhancing the productivity of fluted pumpkin (*Telfairia occidentalis*). This study demonstrated that the two local substrates produced complementary nutritional architectures. The sawdust biocompost is structurally enriched with Nitrogen heavily driving vegetative yield and tissue mass accumulation. Conversely, the rice husk biocompost possesses superior levels of Phosphorus and Magnesium, which significantly accelerated vertical vine elongation and tendrils development. Both formulations maintained heavy metal concentrations well below hazardous thresholds, ensuring biological safety for crop production. When incorporated, both biocomposts also profoundly improved the soil's chemical matrix by significantly increasing electrostatic surface charge density which structurally cushions the soil against intense leaching. Despite these positive outcomes, this study was limited to a short-term, 8-week greenhouse evaluation using controlled pot experiments, which may not fully reflect long-term residual soil dynamics or open-field agronomic conditions. Additionally, while a rapid priming effect and high mineralization rates were chemically evidenced by soil electrical conductivity shifts, the precise long-term structural impact on native soil organic carbon stability remains unquantified. Future research should focus on multi-season field trials to assess the cumulative residual effects of these lignocellulosic composts on soil health and crop yields over time. Investigations are also needed to evaluate the economic viability of scaling up this biocomposting method for smallholder commercial networks. Subsequent studies should also explore the direct molecular and metabolic profiling of indigenous soil microbial successions to fully map the heterotrophic pathways driving this rapid organic waste breakdown.

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