RESEARCH Egyptian Journal of Agricultural Research

Comparative evaluation of the biological, chemical properties, and nutrient content of *Tithonia diversifolia* and Cassava peel composts as sustainable soil amendments

*Adeyinka K. Adebayo *; Samson O. Olanipekun; Folake B. Anjorin and Tolulope E. Ogedengbe*
Address:
Institute of Agricultural Research and Training, Obafemi Awolowo University, PMB 5029, Moor Plantation, Ibadan, Nigeria
*Corresponding author: ***Adeyinka K. Adebayo.*** email: adebayokehinde0410@gmail.com
Received: 10-01-2025; **Accepted:** 12-03-2025; **Published:** 23-03-2025 **DOI:** 10.21608/ejar.2025.351937.1630

ABSTRACT
The increasing demand for sustainable agricultural practices necessitates exploration of organic waste materials as effective soil amendments. This study evaluated microbial activity, chemical properties, and nutrient content of compost derived from cassava peels and *Tithonia diversifolia* in a 1:3 ratio by dry weight, each mixed with poultry manure under controlled conditions. Throughout composting process, parameters such as temperature, pH, carbon dioxide (CO_2) levels, microbial activity, and nutrient content were evaluated. Nutrient contents were determined according to standard procedures and data were analyzed using analysis of variance (ANOVA) at α=0.05. Results showed that cassava peel compost (CPC) maintaining higher bacterial counts, peaking at week 6 (11×10^7 cfu/ml), while Tithonia Compost (TC) peaked earlier at Week 4 (7.2×10^7 cfu/ml). Fungal counts were consistently higher in CPC. Moisture content decreased over time, with CPC retaining slightly more moisture than TC. Temperature trends revealed higher initial temperatures and microbial activity in CPC, peaking at 62.2°C, while TC peaked at 57.6°C. CPC exhibited a mildly acidic pH (6.67) that gradually increased to neutral/slightly alkaline levels by end of composting, while TC was consistently alkaline, stabilizing at 8.37. TC exhibited higher nutrient content, attributed to its rich organic matter and lower C/N ratio, which expedited microbial decomposition and high nutrient release. However, CPC had a higher C/N ratio and fungal activity resulting in gradual nutrient release. Complementary use of TC and CPC on field trials is recommended to assess their long-term effects on soil health and crop yield under different agronomic conditions.
Keywords: Cassava Peel, Tithonia, Compost, Nutrient Content.

INTRODUCTION
Demand for sustainable agricultural methods is rising globally as a result of the urgent need to address the negative effects that conventional agricultural practices have on the environment, society, and economy (Durham and Mizik, 2021). Ecosystem health, food security, and environmental sustainability are all significantly impacted by the continuous loss of soil fertility, which is mostly brought on by intensive farming methods and the overuse of synthetic fertilizers (Josep *et al.,* 2023). According to (Rahman *et al.*, 2022), intensive agriculture has resulted in soil erosion, nutrient depletion, and salinization. It is typified by monoculture farming, high mechanical use, and excessive irrigation. Soil deterioration has been made worse by an over-reliance on synthetic fertilizers which has also contaminated streams and endangered biodiversity (Belete and Yadete, 2023). Soil formation, nitrogen cycling, and carbon sequestration are among the ecosystem services that have been harmed by these unsustainable practices, endangering both environmental sustainability and food security (Marín-Sanleandro *et al.,* 2023; Telo da Gama, 2023). Composting has become a viable strategy to support sustainable agriculture in response to these issues. Composting involves the biological decomposition of organic waste materials, such as crop residues (e.g cassava peel, *Tithonia diversifolia*), animal manure (cow dung, poultry mature, et.c) and municipal waste, into nutrient-rich soil amendments (Manea *et al.,* 2024). This approach offers several benefits, including, mitigation of waste disposal issues, soil fertility enhancement and promotion of sustainable agriculture.

Utilizing composting's has enormous potential for transformation into more regenerative and sustainable farming practices, guaranteeing the long-term well-being and output of our ecosystems, communities, and soils (Nguefack *et al.,* 2020; Abass *et al.,* 2024). Cassava peels and *T. diversifolia* (Mexican sunflower) are two organic materials that have gained a lot of attention in the tropical and subtropical areas mainly composting substrates potential. (Fasae and Yusuf, 2022; Ojewole *et al.,* 2023). These materials are excellent choices for composting since they are readily available, abundant and rich in essential nutrients. The perennial shrub *T. diversifolia* grows quickly and is found in tropical and subtropical regions (Babajide *et al.,* 2012). It is a great source of potassium, phosphate, and nitrogen, among other nutrients (Opala *et al.,* 2020). Since *T. diversifolia* may supply vital minerals for plant growth, its high content of nutrients makes it an excellent choice for composting (Setyowati *et al.,* 2022). On the other hand, cassava peels are generated in immense amounts as a by-product of processing cassava. As reported by (Afolabi and Kareem, 2022), the peels are high in organic carbon and vital minerals like potassium. Peels from cassava are a great source of carbon-rich materials, which are necessary to balance the nitrogen-rich elements in composting (Amadi *et al.,* 2024) Although cassava peels and *T. diversifolia* have advantages on their own, a thorough assessment of their nutrient content, chemical composition and biological properties is essential to ascertain whether they are suitable as long-term soil supplements. The results of this evaluation will offer important information about the composting process and the availability of nutrients in these materials as composting substrates. Ultimately, this knowledge will support sustainable food production and ecosystem services by helping to establish economically and environmentally friendly agricultural practices. Consequently, this study compares the biological, chemical and nutritional content of composts made from cassava peel and *T. diversifolia* during composting.

MATERIALS AND METHODS

Composting:

The heap method was employed, combining *T. diversifolia* and cassava peel with poultry manure. This mixture followed the Partially Aerated Composting Technique (PACT-2) at a 3:1 ratio of plant material to poultry manure on a dry weight basis, as outlined by (Adediran *et al.,* (2003). To accelerate decomposition, each compost heap was turned and watered regularly every two weeks until maturity, using a garden fork. Throughout the 12-week composting period, samples were collected at two weeks interval for nutrient analysis. Additionally, physical and biological properties such as pH, temperature, moisture content, and CO_2 evolution were monitored every two weeks until the compost matured (AAFRD, 2005).

Compost temperature:

Using a soil thermometer, the compost heaps' middle and edges were measured for temperatures at various points. Every point was collected, and the average means were noted.

Moisture content determination:

A known weight crucible was filled with two grams (2g) of compost sample. After the sample and crucible were placed in an oven set at 100º for two hours to dry, they were taken out and placed in a desiccator. This was allowed to cool for ten minutes and weighed.

$$\%moisture \ = \ W1 - W0 \ \times 100/\ W1 - W0$$

Weight of empty is W_0

Sample weight: W_1

Compost pH:

To measure the pH of the compost, a Jenwey digital pH meter was used. Buffer 7 and 4 were used to standardize the meter. 1g of each compost sample was weighed into pH cup and distilled water (one milliliter) was added. The mixture was stirred one after the other and then allowed to settle and pH of each sample was taken with the use of pH meter and was recorded. This procedure was repeated for other samples taken at the weekly interval.

Carbon dioxide evolution determination:

Microbial activity was measured using the incubation-alkaline absorption method (Coleman *et al.,* 1978). Moisture-adjusted subsamples were prepared following the approach of (Forster, 1995) and then placed in a suspended beaker containing 10 mL of 0.05 M NaOH. The jars were incubated at 25°C in the dark for three days immediately after sealing. After the incubation period, the CO_2 trapped in NaOH was titrated with 0.05 M HCl. The respiration rate was calculated as described by (Eze *et al.,* 2013) and expressed as the amount of CO_2 evolved per gram of compost per hour (μg CO_2 g^{-1} soil h^{-1}).

Bacterial and Fungal Count:

This was carried out all through composting and storage period using pour plate. Each week, 1.0 g of compost was collected from each compost heap and diluted tenfold with sterile normal saline. A 0.1 mL aliquot from the 10^7 dilution was inoculated onto nutrient agar and potato dextrose agar using the pour plate technique to determine the population of viable bacterial and fungal cells. To make the potato dextrose agar selective for fungi, 50 µg/ml of chloramphenicol was added. The plates were incubated at 30°C, with bacterial samples incubated for 24 hours and fungal samples for 5 days (Rebollido *et al.,* 2008).

Chemical analysis:

Total phosphorus, Potassium, Calcium, and Magnesium were measured in Aqua Regia digested samples and the results were read using an atomic absorption spectrophotometer (Chen and Ma, 2001). The determination of total N was done using the modified Micro-Kjeldahl method (AOAC, 1980). For the calculation of total phosphorus, (Jackson's, 1973) approach was used. A flame meter was used to measure the potassium. According to (Blakemore *et al.*, 1981), Zn was measured using the aqua regia method, which was also read on the atomic absorption spectrophotometer (AAS) and described by (Hseu *et al.*, 2002).

Data collection:

Chemical properties (Nitrogen, Phosphorus, Potassium, Calcium, Potassium, Magnesium and Zinc) and physical and biological properties such as Ph, temperature, moisture content, and CO_2 evolution during composting were recorded every two weeks.

Data Analysis:

All Data collected were subjected to statistical analysis of variance (ANOVA) using the SAS (2003) software package. The treatments means were separated for significant difference using Duncan Multiple Range Test (DMRT) at 5% level of probability (Duncan, 1955).

RESULTS

Chemical properties of composting materials used for compost:

Table1 compares the nutrient composition of three different organic materials used before composting. Cassava peel compost has a mildly acidic pH (6.67). TC and poultry manure were more alkaline, with pH values of 7.64 and 7.48, respectively. Slightly alkaline or neutral pH values (around 6-7). The TC has the highest nitrogen content at 2.38%, Poultry manure has a similar nitrogen level to cassava peel compost (1.21% and1.17% respectively). Poultry manure has the highest phosphorus concentration (0.59%), followed by TC (0.37%) and cassava peel compost (0.13%). The TC is also rich in potassium (2.09%), more than cassava peel compost (1.25%) and poultry manure (1.35%). TC contains the highest calcium and magnesium level (2.15% and 1.05%), followed by cassava peel compost (1.94% and 0.62) and poultry manure (1.89%).

Table 1. Chemical properties of composting materials.

Nutrient	Cassava peel	Tithonia	Poultry manure
pH	6.67	7.64	7.48
Organic Carbon (%)	43.7	15.60	25.12
Nitrogen (%)	1.17	1.76	3.17
C/N Ratio	37.35	8.86	7.92
Phosphorus (%)	0.13	0.37	0.59
Potassium (%)	1.25	2.09	1.35
Calcium (%)	1.94	2.15	1.89
Magnesium (%)	0.62	1.05	0.97
Zinc (%)	307.54	284.26	184.35

Temperature, moisture content, Co_2 and ph values of composting materials during composting:

The pH of TC starts at 6.70 in week 1 and rises slightly to 6.92 in week 2. By week 4, it increases further to 7.03 and continues to rise. From week 6 onward, the pH follows an upward trend, reaching 8.37 by week 12. In contrast, Cassava peel compost starts with a pH of 6.39 in Week 1 and gradually rises, reaching 8.50 by week 12. However, in both types of compost, the pH steadily increases over time, eventually stabilizing at a neutral to slightly alkaline level by the end of the composting period (Table 2). pH level in each compost heaps was significantly higher at week 12 of composting across the sampling periods. TC starts with a moisture content of 60% in week 1, remaining similar at 60.3% in week 2. From week 4 onward, moisture steadily declines, reaching 21.8% by Week 12, indicating substantial drying over time. CPC begins with a higher moisture content of 68.8% in week 1, which decreases to 61% by week 2 and continues to decline gradually, reaching 24.3% by week 12. However, they both exhibit a similar drying pattern; CPC often holds onto a little bit more moisture over the course of the period than TC (Fig 1).

TC has active microbial activity as it starts at 35°C in week 1 and peaks at 57.6°C in week 2. The temperature of the compost heaps was significantly higher in week 2 of the composting period, regardless of the type of composting materials used. As microbial activity stops and the compost ages, the temperature then steadily drops to 50.9°C by week 4 and stays there until week 12, when it stabilizes at 29.1°C. CPC starts with a higher initial temperature of 45°C in week 1 and reaches its peak at 62.2°C in week 2, slightly higher than TC. Like TC, it gradually cools over time, reaching 30°C by week 12. In general, and particularly during the first few weeks, CPC keeps a little warmer than TC. (Table 2).

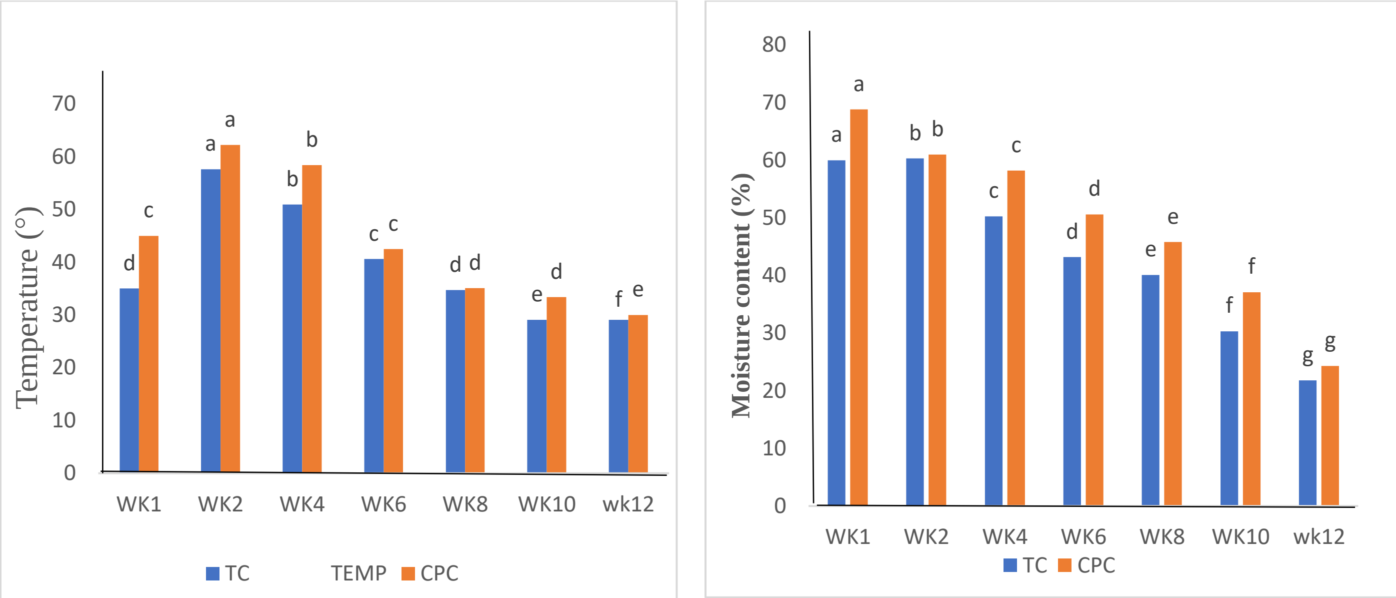

Fig. 1. Temperature and moisture content of composting materials during composting
The same letter followed by the mean inside a column does not significantly differ, according to DMRT at P=0.5. TC: Tithonia compost; CPC: Cassava peel compost.

Table 2. Carbondioxide evolution (Co_2) and pH values of composting materials during composting

Weeks	**pH**		**Co_2 (µMole/mole)**	
	TC	**CPC**	**TC**	**CPC**
WK1	6.70^{e}	6.39^{d}	4.97^{g}	4.22^{g}
WK2	6.92^{d}	7.92^{c}	24.90^{b}	25.00^{b}
WK4	7.03^{d}	7.97^{bc}	26.90^{a}	22.40^{c}
WK6	7.53^{c}	7.63^{c}	23.20^{c}	27.10^{a}
WK8	8.21^{b}	7.77^{c}	17.80^{d}	16.80^{d}
WK10	8.25^{ab}	8.41^{ab}	15.32^{e}	15.70^{e}
WK12	8.37^{a}	8.50^{a}	10.40^{f}	10.80^{f}
SE	0.12	0.13	1.43	1.45
P value	<.0001	<.0001	<0.001	<.0001
L.S.D Value	0.13	0.46	0.11	0.46

The same letter followed by the mean inside a column does not significantly differ, according to DMRT at P=0.05. TC: Tithonia compost; CPC: Cassava peel compost; MC: Moisture content; T: Temperature; CO2: Carbondixoide.

Chemical properties of *T. diversifolia* compost and cassava peel compost during composting:

The nitrogen content decreases a little between weeks 1 and 6, reaching a minimum of 3.54% in week 6. The nitrogen level rises significantly after week 6, increasing at 4.01% at week 12, 3.92% at week 8, and 3.97% at week 10. A similar trend was observed for compost made from CPC, which had a nitrogen content of 2.09% during the first week of composting. The nitrogen amount of the compost is comparatively constant between weeks 2 and 6, ranging between 2.80% and 2.88%. The nitrogen content slightly rises to 2.97% at week 10 decreasing 2.98% at week 12.

Phosphorus (P) Content in TC starts with 0.16% at first week of composting. However, its content increased steadily over times, reaching 0.31% at week 12 of composting. TC shows a significant consistent rise in phosphorus availability, indicating an ongoing release over the 12-week period. Phosphorus levels fluctuate slightly in CPC but generally increase, reaching 0.20% at week 12 of composting. Although the increase is not as pronounced as in TC, CPC does show some increase in phosphorus availability. Significant increase in potassium content over time was observed in potassium content across the composting period. The potassium levels slightly reduce in CPC to 0.44% at Week 8 but then increased to 0.50% to 0.53 % in the final weeks (10 and 12 weeks). The magnesium content exhibited a fluctuating trend throughout the composting process. Initially, it increased slightly from 1.01% in week 1 to 1.28% in week 2 and peaked at 1.35% in week 4. However, it then decreased to 1.30% and 1.29% in weeks 6 and 8, respectively. A subsequent increase was observed, with magnesium content rising to 1.32% and 1.47% in weeks 10 and 12, respectively. (Table 3). TC. Calcium content starts at 3.21% at first week, fluctuates slightly over the composting period, and reaches 3.57% by Week 12 (Table 3).

Bacterial and fungal count:

In general, the fungal counts were higher in CPC across all weeks compared to TC and it was significantly higher at week 4 and 6 with same fungi count 18 x 10^7cfu/ml. However, all compost types show a decrease in fungal count over time, with peaks around WK2-WK6 before gradually declining at WK12. Both Tithonia and cassava peel composts show an increase in bacterial count from WK1 to WK4, with CPC consistently having a higher bacterial population than TC. CPC reaches its peak bacterial count at WK6 (11 x 10^7 cfu/ml), while TC peaks slightly earlier, at WK4 (7.2 x 10^7 cfu/ml). After these peaks, the bacterial count gradually declines for both compost types. By WK12, the bacterial count in both composts has decreased significantly, indicating a reduction in microbial activity. This decline at 12 weeks is consistent with compost maturity, as microbial activity generally decreases when compost reaches stability (Table 4).

Interaction effect of compost types on biological, chemical properties, and nutrient content:

Table 5 shows the interaction effect of CPC and TC on the nutrient content values for Nitrogen (N), Phosphorus (P), Potassium (K), Magnesium (Mg), Calcium (Ca), and Zinc (Zn). TC contains significantly higher levels of nitrogen (3.76%), phosphorus (0.25%), and potassium (0.25%), as well as more calcium (3.28%) compared to CPC (2.78%, 0.14%, 0.49%, and 2.36%, respectively). However, CPC has a significantly higher magnesium content (1.28%) compared to TC (1.13%). CPC exhibited a significantly higher pH (7.80) and MC (47.84%), along with a slightly greater CO_2 evolution (17.64%) compared to TC, which had a pH of 7.56, moisture content of 44.55%, and CO_2 evolution of 17.43%. (Table 5).

Table 3. Chemical properties of *T. diversifolia* compost and cassava peel compost during composting**.**

weeks	Nitrogen (%)		Phosphorus (%)		Potassium (%)		Magnesium (%)		Calcium (%)		zinc (mg/kg)	
	TC	CPC	TC	CPC	TC	CPC	TC	CPC	TC	CPC	TC	CPC
WK1	3.64^{bc}	2.09^{c}	0.16^{b}	0.10	0.53^{de}	0.46	1.20^{b}	1.01^{c}	3.21^{b}	2.23^{c}	360.28^{f}	361.51^{ab}
WK2	3.63^{bc}	2.80^{b}	0.23^{ab}	0.08	0.47^{e}	0.44	1.26^{ab}	1.28^{b}	3.20^{b}	2.07^{d}	362.56^{e}	350.25^{b}
WK4	3.67^{b}	2.88^{ab}	0.25^{ab}	0.15	0.59^{de}	0.48	1.19^{b}	1.35^{ab}	3.29^{b}	2.10^{d}	389.65^{b}	352.83^{b}
WK6	3.54^{c}	2.88^{ab}	0.28^{ab}	0.14	0.64^{d}	0.51	1.03^{c}	1.30^{b}	3.20^{b}	2.41^{b}	362.56^{d}	358.79^{b}
WK8	3.92^{a}	2.91^{ab}	0.26^{ab}	0.17	0.97c	0.44	0.93^{c}	1.29^{b}	3.23^{b}	2.47^{b}	372.58^{c}	350.26^{b}
WK10	3.97^{a}	2.97^{a}	0.29^{a}	0.18	1.23b	0.50	0.99^{c}	1.32^{b}	3.28^{b}	2.50^{b}	392.56^{a}	372.70^{a}
WK12	4.01^{a}	2.98^{a}	0.31^{a}	0.20	1.67^{a}	0.53	1.35^{a}	1.47^{a}	3.57^{a}	2.75^{a}	389.65^{b}	373.51^{a}
S E	0.03	0.05	0.01	0.01	0.08	0.01	0.03	0.02	0.02	0.04	2.33	2.28
P Value	<.0001	<.0001	0.0009	0.23	<.0001	0.75	<.0001	<.0001	<.0001	<.0001	<.0001	0.002
L.S.D Value	0.12	0.12	0.12	----	0.12	----	0.12	0.12	0.13	0.12	0.37	12.74

The same letter followed by the mean inside a column does not significantly differ, according to DMRT at P=0.05. TC: TC; CPC: Cassava peel compost; WK: week; SE: Standard Error

Table 4. Bacterial and fungal count during composting

	Fungal count (10^7cfu/ml)		Bacterial count (10^7cfu/ml)	
Weeks	TC	CPC	TC	CPC
WK1	10^{c}	15^{b}	1.50^{e}	1.97^{e}
WK2	15^{a}	17^{a}	6.1^{b}	9.5^{b}
WK4	13^{b}	18^{a}	7.2^{a}	10.3^{ab}
WK6	12^{b}	18^{a}	6.8^{a}	11.0^{a}
WK8	10^{c}	15^{b}	6^{b}	10.0^{ab}
WK10	8^{d}	13^{c}	5.2^{c}	8.0^{c}
WK12	4^{e}	8^{d}	4.1^{d}	5.8^{d}
S E	0.76	0.75	0.41	0.15
P Value	<.0001	<.0001	<.0001	<.0001
L.S.D Value	1.62	1.75	0.68	1.15

The same letter followed by the mean inside a column does not significantly differ, according to DMRT at P=0.05. TC: Tithonia compost; CPC: Cassava peel compost

Table 5. Effect of compost types on biological, chemical properties, and nutrient content

Compost type	pH	MC (%)	T (0)	Co_2 (μMole/mole)	N (%)	P (%)	K (%)	Mg (%)	Ca (%)	Zn(mg/kg)
CPC	7.80^{a}	47.84^{a}	42.89^{a}	17.64^{a}	2.78^{b}	0.14^{b}	0.49^{b}	1.28^{a}	2.36^{b}	360.01^{b}
TC	7.56^{b}	44.55^{b}	39.84^{b}	17.43^{b}	3.76^{a}	0.25^{a}	0.87^{a}	1.13^{b}	3.28^{a}	373.30^{a}
S. E±	0.13	2.42	2.07	1.45	0.07	0.01	0.04	0.023	0.06	1.84
P value	<.001	<.001	<.001	<.001	<.001	0.0009	<.001	<.001	<.001	<.001
L.S. D	0.12	0.12	0.79	0.13	0.04	0.04	0.04	0.04	0.04	3.32

The same letter followed by the mean inside a column does not significantly differ, according to DMRT at P=0.05, N: Nitrogen, P: Phosphorus, K: Potassium, Mg: Magnesium, Ca: Calcium, Zn: Zinc. Moisture content, T: Temperature, CO2: carbondioxide, CPC: Cassava peel compost, TC: Tithonia compost.

DISCUSSION

The nutrient content of matured compost, including nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg), showed significant increases compared to the initial composting materials. This enhancement shows the importance of composting crop residues, which substantially improves the nutritional quality of the compost (Hashim *et al.,* 2022). By converting crop residues into a nutrient-rich compost, this process supports sustainable agriculture by enhancing soil fertility, promoting plant growth and increasing nutrient content. These findings align with previous research by (Sultana *et al.,* 2021 and Chukwuka and Omotayo, 2009), that similarly reported significant increases in nutrient contents following compost production. The results demonstrated the effectiveness of composting in transforming crop residues into a valuable resource for environmentally friendly agriculture.

The reason for the higher nutrient content in TC compared to cassava peel can be attributed to the differences in the nutrient content and composition of the two organic materials. The effectiveness of these composts varied based on the compost materials used. The improvement observed with tithonia-based compost corresponds with the findings of (Okonji *et al.,* 2023). This study emphasised the importance of factors such as the source and type of organic material of compost in influencing nutrient content. Compared to compost made from cassava peels, the TC had more concentrated and accessible nutrients (Afolabi and Kareem, 2022). Nutrient analysis conducted on matured compost showed that TC had higher levels of nitrogen, phosphorus, potassium, and some micronutrients compared to cassava-based compost. These results corroborated the findings of (Pelu *et al.,* 2020 and Komolafe and Adewole, 2022) who reported the potential of Tithonia biomass as potential fertilizer that could supply adequate nutrients for improved crop yield and nutrient uptakes of crop plants when incorporated into the soil. This follows the research results of (Okonji *et al.,* 2023), who discovered that Tithonia contain many vital nutrients that make them beneficial for improving soil quality.

By understanding the distinct properties of TC and CPC, farmers can tailor their composting practices and usage to meet specific crop and soil requirements. High nutrient content and biological activities in Tithonia compost could be attributed to it rich organic matter and nitrogen levels (Mekonnen *et al.,* 2020 and Ogunwale *et al.,* 2020). Making it ideal for nutrient-demanding crops like maize, vegetables (e.g., tomatoes, spinach, and lettuce), and legumes e.g., lima beans and soybeans (Nhamussua *et al.,* 2020 and Ojewole *et al.,* 2023) particularly in sandy or nutrient-depleted soils where rapid nutrient supply and improved biological activity are crucial (Okorie *et al.,* 2020). In contrast, CPC is unique characteristics make it more suitable for maintaining soil structure or supporting crops with moderate nutrient requirements, such as cassava, yam, and millet. By recognizing these differences, farmers can allocate their resources more efficiently, utilizing TC for critical growth stages or high-value crops and CPC for general soil improvement. This strategic approach ensures sustainable resource utilization and optimum compost benefits. The rapid decomposition of TC facilitates an expedited release of essential nutrients, particularly nitrogen, which promptly supports plant growth (Ojo *et al,* 2021). However, this rapid release may lead to potential leaching losses, especially in sandy soils with poor water retention, resulting in inadequate long-term organic matter accumulation to enhance soil structure and moisture retention. Conversely, high fungal count in CPC enables a gradual breakdown of organic matter, providing a steady and sustained nutrient supply over an extended period (Stegenta-Dabrowska et *al.,* 2022). Fungi effectively decompose lignin and cellulose, abundant in cassava peels, enriching the soil with humus. Nevertheless, elevated fungal counts may decelerate the decomposition process, delaying the release of nutrients crucial for fast-growing crops. Consequently, the compost may require a longer maturation period, potentially deferring its availability for immediate application. To mitigate these trade-offs, farmers can consider combining both compost types. For instance, TC can be utilized for crops requiring immediate nutrient availability, whereas CPC can provide sustained soil benefits (Onguene *et al.,* 2021). Farmers in regions prone to nutrient leaching may prefer CPC for its slower release, while those necessitating rapid crop turnover may prioritize TC.

The utilization of TC and cassava peel compost CPC offers numerous environmental benefits, aligning with sustainable agricultural practices. TC, derived from a rapidly regenerating plant, provides an efficient and renewable resource. In contrast, CPC leverages a byproduct of food processing, addressing waste management challenges and promoting a circular economy (Hernandez *et al.,* 2023). The distinct characteristics of each compost type make them suited for specific applications. Tithonia compost is high nitrogen content facilitates rapid nutrient cycling, ideal for intensive farming systems. Conversely, CPC gradual nutrient release and soil structure improvement enhance long-term soil resilience (Okonji *et al.,* 2023). By adopting TC and CPC, farmers can reduce their reliance on synthetic fertilizers, which are energy-intensive to produce and contribute to greenhouse gas emissions (Hu *et al.,* 2020). Both composts enrich soil organic matter, improve water retention, and support beneficial soil organisms, culminating in healthier and more resilient ecosystems (Dede *et al.*, 2023). Furthermore, composting organic materials like cassava peels and *T. diversifolia* helps mitigate climate change by reducing methane emissions from unmanaged organic waste. To maximize the sustainability benefits of TC and CPC, their use should be balanced based on local availability, crop requirements, and environmental conditions (Agbogidi *et al.,* 2023).

The carbon-to-nitrogen (C/N) ratio is a critical determinant of compost maturity and quality (Qu e*t al.,* 2020). A balanced C/N ratio is essential for optimal microbial activity, which drives the decomposition process (Aboutayeb *et al.,* 2021). A comparative analysis of TC and CPC before composting, revealed distinct C/N ratios, influencing their composting dynamics and maturation rates. The initial carbon content of cassava peel, measured at 43.7%, indicates that elevated carbon levels can impede the decomposition process (El-mrini *et al.,* 2022). Consequently, cassava peel compost exhibits a prolonged maturation period due to its higher C/N ratio (Dewilda *et al.,* 2024). Microorganisms must first degrade the excess carbon before utilizing the nitrogen, resulting in slower decomposition rates and a more gradual stabilization of the compost (Zhang *et al.,* 2020 and Nemet *et al.,* 2021). In contrast, *T. diversifolia,* a plant species commonly employed for composting, exhibits relatively high nitrogen content compared to other organic materials (Kumar *et al.,* 2017). The lower C/N ratio and higher nitrogen content in Tithonia compost facilitate accelerated microbial activity, thereby expediting the decomposition process (Singh *et al.,* 2018). This, in turn, yields a more mature and stable compost within a shorter timeframe.

CONCLUSION

This study highlights the viability of cassava peel compost (CPC) and *T. diversifolia* compost (TC) as sustainable organic soil amendments, owing to their unique nutrient contents. The utilization of these composts offers a cost-effective alternative to synthetic fertilizers, thereby enhancing the economic viability of agricultural practices for resource-constrained farmers. However, to enhance the generalizability of the findings, future studies should investigate the composting characteristics and nutrient release patterns of other organic materials, including mixed or alternative feedstock's commonly used in diverse farming systems. Additionally, exploring the impact of varying environmental conditions on the composting process and nutrient release patterns would provide valuable insights. Also, further studies should explore the combined application of these compost types (CPC and TC) to leverage their complementary strengths under field trials and to validate their efficacy and assess their long-term impacts on crop yield and soil health under varying agronomic conditions.

REFERENCES

AAFRD, (2005). Composting manual livestock engineering unit and environmental practice unit technical services division Alberta Agriculture, *Food and Rural Development,* 1-21.

Abbas, A., Naveed, M., Shehzad Khan, K., Ashraf, M., Siddiqui, M. H., Abbas, N., Mustafa, A., & Ali, L. (2024). The efficacy of organic amendments on maize productivity, soil properties and active fractions of soil carbon in organic-matter deficient soil. *Spanish Journal of Soil Science*, *14*, 12814.

Aboutayeb, R., El-Mrini, S., Zouhri, A., Idrissi, O., & Azim, K. (2021). Hygienization assessment during heap co-composting of Turkey manure and olive mill pomace. *Eurasian Journal of Soil Science*, *10*(4), 332-342.

Adediran, J. A., De Baets, N., Mnkeni, P. N. S., Kiekens, L., Muyima, N. Y. O., & Thys, A. (2003). Organic waste materials for soil fertility improvement in the border region of the Eastern Cape, South Africa. *Biological agriculture & horticulture*, *20*(4), 283-300.

Afolabi, A., & Kareem, T. (2022). Evaluating the nutrient profiles of cassava peel and *Tithonia diversifolia*-based compost. *Sustainable Agriculture Reviews,* 39(2), 67-74.

Agbogidi, O.M., Edokpiawe, S., Okpewho, O.P., & Ogbemudia, C.O. (2023). Effects of cassava processing wastewater on the performance of maize (*Zea mays L.*). *Nigerian Journal of Science and Environment,* 21(1), 358-368

Amadi, N., Yabrade, M., & Okubor, P. C. (2024). Impact of cassava peel on soil nutrient and microbial restoration of crude oil contaminated soil in Rivers State, Nigeria. *Scientia Africana*, *23*(4), 141-156.

Association of Official Analytical Chemists, & Association of Official Agricultural Chemists (US). (1980). *Official and Tentative Methods of Analysis* (Vol. 13).

Babajide, P. A., Akanbi, W. B., Olabode, O. S., Olaniyi, J. O., & Ajibola, A. T. (2012). Influence of pre-application handling techniques of *Tithonia diversifolia* Hemsl. A. Gray residues on sesame, in south-western Nigeria. *Journal of Animal and Plant Sciences*, 15, 2135-2146.

Belete, T., & Yadete, E. (2023). Effect of mono cropping on soil health and fertility management for sustainable agriculture practices: A review. *Journal of Plant Sciences, 11(6), 192-197.*

Blakemore, L.C., Seale, P.L., & Daly, B.K. (1981). Methods of chemical analysis of soils. New Zealand Soil Bureau, NZ Department of Scientific and Industrial Research, New Zealand. 103.

Chen, M., & Ma, L. Q. (2001). Comparison of three aqua regia digestion methods for twenty Florida soils. *Soil science society of America Journal*, *65*(2), 491-499.

Chukwuka, K. S., & Omotayo, O. E. (2008). Effects of Tithonia green manure and water hyacinth compost application on nutrient depleted soil in South-Western Nigeria. *International journal of soil science*, *3*(2), 69-74.

Coleman, D. C., Anderson, R. V., Cole, C. V., Elliott, E. T., Woods, L., & Campion, M. K. (1977). Trophic interactions in soils as they affect energy and nutrient dynamics. IV. Flows of metabolic and biomass carbon. *Microbial Ecology*, *4*, 373-380.

Dede, C., Ozer, H., Dede, O. H., Celebi, A., & Ozdemir, S. (2023). Recycling nutrient-rich municipal wastes into ready-to-use potting soil: An approach for the sustainable resource circularity with inorganic porous materials. *Horticulturae*, *9*(2), 203.

Dewilda, Y., Aziz, R., & Zahra, S. (2024, March). Utilization of banana and cassava peel as local microorganism materials in household organic waste composting by takakura method. In *IOP Conference Series: Earth and Environmental Science* 1306 (1), 012039.

Duncan, D. B. (1955). Multiple range and multiple F tests. *biometrics*, *11*(1), 1-42.

Durham, T. C., & Mizik, T. (2021). Comparative economics of conventional, organic, and alternative agricultural production systems. *Economies*, *9*(2), 64-68

El-mrini, S., Aboutayeb, R., & Zouhri, A. (2022). Effect of initial C/N ratio and turning frequency on quality of final compost of turkey manure and olive pomace. *Journal of Engineering and Applied Science*, *69*(1), 37.

CN, E., Ogbonna, J. C., Anyanwu, C. U., & Eze, E. A. (2013). Determination of the relative abundance and distribution of bacteria and fungi in Bonny light crude oil-contaminated sandy loam soil. *Scientific Research and Essays*, *8*(9), 375-381.

Fasae, O. A., & Yusuf, A. O. (2022). Cassava leaves and peels: Nutritional value and potential productivity in West African dwarf breeds of sheep and goats–A review. *Nigerian Journal of Animal Production*, *49*(3), 301-311.

Forster, J.C. (1995). Soil physical analysis. In: Methods in applied soil microbiology and biochemistry. Alef, K., Nannipieri, P. (Eds.). Academic Press, San Diego, CA. USA. 105–122.

Hashim, S., Waqas, M., Rudra, R. P., Akhtar Khan, A., Mirani, A. A., Sultan, T., Ehsan, F., Abid, M., & Saifullah, M. (2022). On-Farm Composting of Agricultural Waste Materials for Sustainable Agriculture in Pakistan. *Scientifica*, *2022*(1), 5831832.

Hernandez, Y., Garcia, M., & Flores, J. (2023). Affordable composting solutions for low-resource farmers. *Agriculture and Rural Development,* 11(4), 92-100.

Hseu, Z. Y., Chen, Z. S., Tsai, C. C., Tsui, C. C., Cheng, S. F., Liu, C. L., & Lin, H. T. (2002). Digestion methods for total heavy metals in sediments and soils. *Water, Air, and Soil pollution*, *141*, 189-205.

Hu, Q., Liu, T., Jiang, S., Cao, C., Li, C., Chen, B., & Liu, J. (2020). Combined effects of straw returning and chemical N fertilization on greenhouse gas emissions and yield from paddy fields in Northwest Hubei Province, China. *Journal of Soil Science and Plant Nutrition*, *20*, 392-406.

Jackson, M. L. (1973). Soil chemical analysis, pentice hall of India Pvt. *Ltd., New Delhi, India*, *498*, 151-154.

Penuelas, J., Coello, F., & Sardans, J. (2023). A better use of fertilizers is needed for global food security and environmental sustainability. *Agriculture & Food Security*, *12*(1), 1-9.

Komolafe, O., & Adewole, M. (2022). Effect of different fertilizers on yield and grain composition of maize in the tropical rainforest zone. *Agronomía Colombiana*, *40*(3), 411-418.

Kumar, S., Shekhar, S., & Kumar, V. (2017). *Tithonia diversifolia*: A review on its phytochemistry, pharmacology and traditional uses. *Journal of Ethnopharmacology,* 206, 241-253.

Manea, E. E., Bumbac, C., Dinu, L. R., Bumbac, M., & Nicolescu, C. M. (2024). Composting as a sustainable solution for organic solid waste management: Current practices and potential improvements. *Sustainability*, *16*(15), 6329.

Marín-Sanleandro, P., Gómez-García, A. M., Blanco-Bernardeau, A., Gil-Vázquez, J. M., & Alías-Linares, M. A. (2023). Influence of the type and use of soil on the distribution of organic carbon and other soil properties in a sustainable and resilient agropolitan system. *Forests*, *14*(6), 1085.

Mekonnen, D., Berhanu, A., & Alemu, M. (2020). Nutrient composition and fertilizer value of *Tithonia diversifolia* leaves. *Journal of Environmental Science and Health*, 55, 1-8.

Nemet, F., Perić, K., & Lončarić, Z. (2021). Microbiological activities in the composting process–A review. *COLUMELLA–Journal of Agricultural and Environmental Sciences*, *8*(2), 41-53.

Nguefack, J., Mewouo, Y. C. M., Lekagne, J. B. D., Djoufack, M. M., Fotio, D., Daboy, C. D., & Fouelefack, F. R. (2020). Nitrogen Use Efficiency (NUE) in tomato (*Solanum lycopersicum*) seedlings in response to treatment with extract of *Cymbopogon citratus* and mineralization of *Tithonia diversifolia* leaves and cow dung. *International Journal of Environment, Agriculture and Biotechnology*, *5*(2), 916-927.

Nhamussua, L., Mabota, M., & Mancama, M. (2020). Effects of *Tithonia diversifolia* compost on growth and yield of tomato (*Solanum lycopersicum L*.). *Journal of Horticultural Science and Biotechnology*, 95(3), 1-8.

Ogunwale, J. A., Olaleye, A. O., & Adejuyigbe, C. O. (2020). Composting of *Tithonia diversifolia* and its effects on soil properties and maize yield. *Journal of Composting Science and Utilization*, 28(1), 1-10.

Ojewole, G.O., Pam, H.D., Joseph, E., Idrisu, M., Liadi, M.T., & Oyerinde, A.A. (2023). Evaluation of *Tithonia diversifolia* and cattle dung on the growth of maize at University of Abuja Teaching and Research Farm. *Journal for Undergraduate Research,* 1(2),1-5.

Ojo, A. O., Uthman, A. C. O., & Ogunmola, J. R. (2021). Changes in chemical and biological properties during co-composting of swine dung and different plant materials. *Eurasian Journal of Soil Science*, *10*(1), 17-25.

Okonji, C. J., Adewale, D., Obisesan, O. I., Osundare, O. I., & Ahaneku, C. G. (2023). Impact of *Tithonia diversifolia* as green manure amendment on yield and yield attributes of maize (*Zea mays*.). *Badeggi Journal of Agricultural Research and Environment*, *5*(1), 01-14.

Okorie, O. O., Ayeni, L. S., & Ogunwole, J. O. (2020). Evaluation of *Tithonia diversifolia* compost as a soil amendment for improved soil fertility and crop yield. *Journal of Agricultural Science and Practice,* 5(1), 1-8.

Nguefack, J., Lekagne, J. B. D., Daboy, C. D., & Mangoumou, G. N. (2021). The potential of cassava *(Manihot esculenta* Crantz) peels as an organic fertilizer. *International Annals of Science*, *10*(1), 107-117.

Opala, P. A. (2020). Recent advances in the use of *Tithonia diversifolia* green manure for soil fertility management in Africa: a review. *Agricultural Reviews*, *41*(3), 256-263.

Pelu, J., Tyasmoro, S. Y., & Maghfoer, M. D. (2020). Effect bulking agent on composting mexican sunflower (*Tithonia diversifolia* L) biomass and utilization on pak choi production. *Agromix*, *11*(1), 49-65.

Qu, J., Zhang, L., Zhang, X., Gao, L., & Tian, Y. (2020). Biochar combined with gypsum reduces both nitrogen and carbon losses during agricultural waste composting and enhances overall compost quality by regulating microbial activities and functions. *Bioresource Technology*, *314*, 123781.

Rahman, S., Jama Ali, A., & Raihan, A. (2022). Soil carbon sequestration in agroforestry systems as a mitigation strategy of climate change: a case study from Dinajpur, Bangladesh. *Advances in Environmental and Engineering Research*, *3*(4), 1-13.

Rebollido, R. O. C. I. O., Martinez, J. O. R. G. E., Aguilera, Y. U. R. I., Melchor, K. E. N. I. A., Körner, I., & Stegmann, R. A. I. G. N. E. R. (2008). Microbial populations during composting process of organic fraction of municipal solid waste. *Applied ecology and environmental research*, *6*(3), 61-67.

Setyowati, N., Hutapea, J. V., & Muktamar, Z. (2022). Mexican sunflower (*Tithonia diversifolia*) compost as substitution of synthetic fertilizers for sweet corn in Ultisols. *International Journal of Agricultural Technology,* 18(6), 2607-2616.

Singh, J., Kaur, A., & Vig, A. P. (2018). *Tithonia diversifolia*: A valuable plant for composting and soil health. *Journal of Cleaner Production*, 172, 2261-2268.

Stegenta-Dąbrowska, S., Sobieraj, K., Rosik, J., Sidełko, R., Valentin, M., & Białowiec, A. (2022). The Development of Anammox and Chloroflexi Bacteria during the Composting of Sewage Sludge. *Sustainability*, *14*(16), 10248.

Sultana, M., Jahiruddin, M., Islam, M. R., Rahman, M. M., Abedin, M. A., & Solaiman, Z. M. (2021). Nutrient enriched municipal solid waste compost increases yield, nutrient content and balance in rice. *Sustainability*, *13*(3), 1047.

Telo da Gama, J. (2023). The role of soils in sustainability, climate change, and ecosystem services: Challenges and opportunities. *Ecologies*, *4*(3), 552-567.

Zhang, W., Yu, C., Wang, X., & Hai, L. (2020). Increased abundance of nitrogen transforming bacteria by higher C/N ratio reduces the total losses of N and C in chicken manure and corn stover mix composting. *Bioresource Technology*, *297*, 122410.