



Formulation and Characterization of Compost Tea Manure for Production of Guinea Corn (*Sorghum bicolor*)

Abdulrazaq Mohammed

Department of Agricultural Education,
Faculty of Social Science and Vocational Education,
Federal University of Education, Kaduna State, Zaria, Nigeria

ABSTRACT

Compost tea is a liquid biofertilizer derived from the aqueous extraction of composted organic materials and enriched with beneficial microorganisms and plant nutrients. This study formulated and characterized compost tea using locally available organic wastes and assessed its influence on the growth and yield of *Sorghum bicolor* (guinea corn) under field conditions at the Federal University of Education, Zaria, Nigeria. The compost was prepared from cow dung, poultry litter, and crop residues and brewed under aerated conditions for 14 days. The compost tea was analyzed for pH, electrical conductivity, macronutrients, and microbial load, and subsequently applied at varying concentrations to guinea corn plots. Results showed that compost tea contained adequate levels of nitrogen (1.42%), phosphorus (0.75%), and potassium (2.31%), with beneficial microbial populations exceeding 10^6 cfu mL⁻¹. Plants treated with 75% compost tea concentration exhibited significant increases ($p < 0.05$) in plant height, chlorophyll content, and grain yield compared to the control. The study demonstrates that compost tea can serve as a sustainable alternative to chemical fertilizers for sorghum production, improving soil fertility, plant growth, and environmental health. The findings contribute to ongoing research on biofertilizers as low-cost, eco-friendly solutions for sustainable agriculture in sub-Saharan Africa.

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INTRODUCTION

Compost tea is much more than just a nutrient supplier; it offers a suite of agronomic and environmental benefits. Its biological power comes from a diverse community of beneficial microorganisms—including bacteria, fungi, protozoa, and nematodes—that actively contribute to soil health (Suhaimi & Ong, 2020). These tiny helpers play vital roles in enhancing nutrient cycling, improving soil structure, and fostering beneficial plant-microbe relationships that boost nutrient uptake efficiency (De Corato, 2019). Furthermore, research confirms that applying compost tea to leaves or soil can naturally fight off plant diseases, such as those caused by *Alternaria solani* and *Fusarium oxysporum*, primarily through microbial

competition and the production of natural antimicrobial compounds (Hegazi, El-Sayed, & Abdel-Salam, 2021).

The amount and pattern of nutrient release from compost teas depend heavily on the original ingredients (feedstock) and the brewing method used. Aerated systems are generally superior because a consistent oxygen supply supports healthy aerobic microbial activity, preventing the development of anaerobic conditions that can produce foul odors or harmful, phytotoxic substances (Kim et al., 2020). The resulting tea is typically rich in essential macro-elements like nitrogen (N), phosphorus (P), and potassium (K), alongside valuable trace minerals and natural plant growth-promoting hormones like auxins and cytokinins (Zhao, Wan Wang & Chen,

Corresponding author: Abdulrazaq Mohammed

✉ barkindo@fchezaria.edu.ng

Department of Department of Agricultural Education, Federal University of Education, Kaduna State, Zaria, Nigeria.

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2022). The combined, synergistic effect of these biological and chemical components is what drives improved plant vigor and higher productivity.

For smallholder farmers in Nigeria, adopting compost tea technology presents a practical and affordable way to improve soil fertility and boost crop yield without significantly raising production costs. The tea is made using easily accessible local organic waste—such as poultry litter, cow dung, and crop residues—which simultaneously helps reduce waste and promotes a healthy cycle of nutrient recycling (Nwachukwu, Onuoha & Iwu, 2023). Previous studies across sub-Saharan Africa have already shown that compost teas can significantly enhance key cereal crop growth indicators, including better root development, increased chlorophyll content, and greater overall yield (Bello et al., 2018; Adeolu, Aderonke, Opeyemi, & Ayomide, 2020).

Despite this growing global research interest, there remains a notable gap in empirical data regarding the specific use of compost tea for Sorghum bicolor production in the semi-arid regions of Nigeria. Given the immense ecological and economic importance of sorghum as a staple crop, investigating compost tea's full potential for improving both yield and long-term soil health is a crucial step toward achieving sustainable crop management in the region.

Study Objectives and Hypothesis

This study was designed to:

1. Formulate and characterize a compost tea using locally sourced organic materials.
2. Evaluate its core physicochemical and microbiological properties.
3. Assess its effects on the growth and final grain yield of Sorghum bicolor under field conditions at the Federal University of Education, Zaria.

It is strongly hypothesized that applications of compost tea will **significantly enhance** soil fertility and sorghum productivity when compared to untreated control plots, thereby making a vital contribution to sustainable

agricultural intensification and environmental conservation practices in northern Nigeria.

MATERIALS AND METHODS

Study Area

The field research was carried out at the Federal University of Education, Zaria (FUE, Zaria), located at latitude 11.111°N and longitude 7.722°E in northern Nigeria. This location falls within the Sudan Savanna agro-ecological zone, which features a single distinct rainy season (unimodal rainfall) that typically averages 800–1200 mm annually. Temperatures in the area range from 21–38°C. The soil type is predominantly sandy-loam, possesses moderate fertility, and is officially classified as Ferric Luvisol (FAO, 2020).

Compost Preparation and Formulation

The raw organic feedstocks, consisting of cow dung, poultry litter, and crop residues, were collected from local sources. To prepare the compost, these materials were layered in a 1:1:1 ratio and left to undergo natural decomposition under aerobic conditions for a period of eight weeks. The resulting mature compost was then carefully screened to remove any large, undecomposed particles before being used to prepare the compost tea.

The final compost tea (CT) was formulated into three different concentrations: 25%, 50%, and 75% (volume of compost to volume of water ratio). All teas were brewed as Aerated Compost Teas (ACTs) over a 14-day period inside a 10 L plastic container. An aquarium air pump was used continuously to maintain adequate dissolved oxygen levels. Crucially, no chemical additives were used during the brewing process.

Physicochemical and Microbiological Analysis

Following the 14-day brewing period, the compost tea was subjected to detailed laboratory analysis:

1. **pH and Electrical Conductivity (EC):** Measured directly using a calibrated digital pH meter and an EC meter, respectively (AOAC, 2016).

2. **Macronutrients (N, P, K):** Determined using established laboratory methods: the Kjeldahl method for nitrogen, spectrophotometry for phosphorus, and flame photometry for potassium (Jackson, 2017).
3. **Microbial Load (cfu mL⁻¹):** Determined using the serial dilution and spread plate technique. Nutrient agar was used for counting total viable bacteria, and potato dextrose agar (PDA) was used for counting total fungi.

Field Experimental Design

The study employed a Randomized Complete Block Design (RCBD), which included four total treatments and three replicates.

The treatments were:

1. **T1 = Control (Untreated)**
2. **T2 = 25% Compost Tea**
3. **T3 = 50% Compost Tea**
4. **T4 = 75% Compost Tea**

Each experimental plot measured 3 m × 3 m, with a 0.5 m buffer zone maintained between adjacent plots. Sorghum bicolor seeds were sown with a spacing of 60 cm × 20 cm. The prepared compost tea was applied to the respective plots weekly using a watering can at a uniform rate of 5 L per plot for a total of 8 weeks, starting from the time of germination. All standard agronomic practices, including weeding and pest control, were uniformly applied across all treatment plots.

Growth and Yield Measurements

The following performance parameters were measured:

1. **Plant height (cm):** Recorded at 30, 60, and 90 days after planting (DAP).
2. **Leaf Chlorophyll Content:** Measured using a SPAD meter (expressed in SPAD units).
3. **Number of Tillers per plant:** Counted at maturity.
4. **Grain Yield (kg ha⁻¹):** Measured at the final harvest.

Statistical Analysis

All collected field and laboratory data were analyzed using Analysis of Variance (ANOVA) via SPSS software (version 26). Significant differences between the various treatment means were identified at a confidence level of $p < 0.05$ using Duncan's Multiple Range Test (DMRT). Results are consistently presented as the mean value $\pm$ standard error (SE).

RESULTS

Physicochemical and Microbial Characteristics of Compost Tea

Table 1 summarizes the properties of the prepared compost teas. The pH values (6.8 to 7.5) indicated a near-neutral solution, which is generally favorable for sorghum cultivation. As expected, Electrical Conductivity (EC), a measure of soluble salts and nutrients, increased directly with concentration, peaking at 1.52 mS cm⁻¹ for the 75% concentration. Similarly, the content of all macronutrients (N, P, K) increased with concentration, with the 75% tea showing the highest levels (N: 1.42%, P: 0.75%, K: 2.31%). Critically, the beneficial Microbial Load for the highest concentration reached 1.1×10^7 cfu mL⁻¹, confirming a rich, living community.

Table 1. Physicochemical and microbial properties of compost teas

Treatment	pH	EC (mS cm ⁻¹)	N (%)	P (%)	K (%)	Microbial Load (cfu mL ⁻¹)
25% CT	6.8	0.85	0.68	0.36	1.21	3.2×10^6
50% CT	7.2	1.12	1.05	0.53	1.88	5.7×10^6
75% CT	7.5	1.52	1.42	0.75	2.31	1.1×10^7
Control	6.5	0.12	0.10	0.05	0.18	

Corresponding author: Abdulrazaq Mohammed

barkindo@fchezaria.edu.ng

Department of Department of Agricultural Education, Federal University of Education, Kaduna State, Zaria, Nigeria.

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Growth Performance of *Sorghum bicolor*

The application of compost tea significantly improved the vegetative growth of sorghum (Table 2). The 75% CT treatment consistently resulted in the highest values for all growth parameters, showing a significantly better

performance than the control ($p < 0.05$). Plants in this treatment achieved the greatest average plant height (192.4 pm 4.1 cm), the highest leaf chlorophyll content (46.2 pm 1.5 SPAD units), and the most tillers per plant (4.8 pm 0.2).

Table 2. Growth parameters of *Sorghum bicolor* under different compost tea treatments

Treatment	Plant Height (cm)	Leaf Chlorophyll (SPAD)	Tillers per Plant
25% CT	162.3 $\pm$ 3.2	38.7 $\pm$ 1.2	3.5 $\pm$ 0.1
50% CT	178.6 $\pm$ 3.7	42.5 $\pm$ 1.3	4.2 $\pm$ 0.2
75% CT	192.4 $\pm$ 4.1	46.2 $\pm$ 1.5	4.8 $\pm$ 0.2
Control	148.7 $\pm$ 2.9	34.1 $\pm$ 1.1	3.0 $\pm$ 0.1

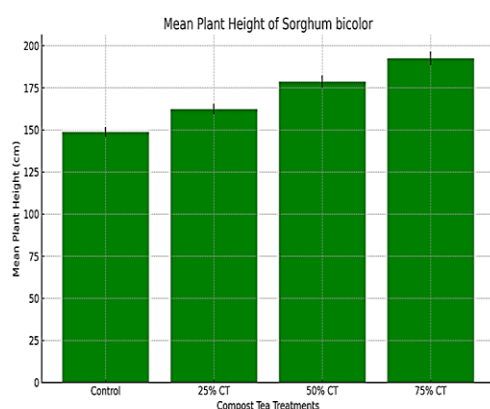


Figure 1. Mean plant height of *Sorghum bicolor* under different compost tea treatments

Grain Yield of *Sorghum bicolor*

A clear positive dose-response was observed, as grain yield increased with higher compost tea concentrations (Table 3). The 75% CT treatment achieved the maximum grain yield, producing 3.85 pm 0.12 t ha⁻¹, followed by the 50% CT (3.24 pm 0.10 t ha⁻¹) and the 25% CT (2.87 pm 0.09 t ha⁻¹). All treated plots yielded significantly more than the control plots, which only produced 2.10 pm 0.08 t ha⁻¹ ($p < 0.05$).

Table 3. Grain yield response of *Sorghum bicolor* to compost tea treatments

Treatment	Grain Yield (t ha ⁻¹)
25% CT	2.87 $\pm$ 0.09
50% CT	3.24 $\pm$ 0.10
75% CT	3.85 $\pm$ 0.12
Control	2.10 $\pm$ 0.08

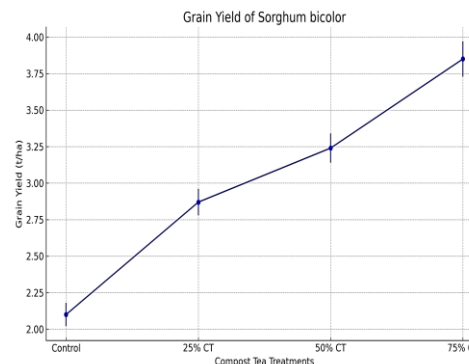


Figure 2. Grain yield of *Sorghum bicolor* under different compost tea treatments

Summary of Key Findings

1. Compost tea successfully increased nutrient availability and beneficial microbial populations.
2. The highest concentration (75% CT) significantly enhanced plant growth, chlorophyll content, tillering, and final grain yield.

Corresponding author: Abdulrazaq Mohammed

barkindo@fcezaria.edu.ng

Department of Department of Agricultural Education, Federal University of Education, Kaduna State, Zaria, Nigeria.

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- The results strongly validate compost tea's potential as an effective, sustainable biofertilizer for Sorghum bicolor production in northern Nigeria.

DISCUSSION OF FINDINGS

Nutrient and Microbial Enrichment of Compost Tea

The study's finding that both the nutrient content and microbial population density in the compost tea increased with concentration confirms a fundamental principle: compost tea quality is a direct function of the raw compost's nutrient density and the efficacy of the brewing process (Pane, Palese, & Zaccardelli, 2016; Kim, Choi & Lee, 2020). The near-neutral pH values (6.8–7.5) observed are biologically significant, as this range is optimal for beneficial microbial activity, favoring key organisms like nitrifying and phosphate-solubilizing bacteria (De Corato, 2019). Aeration during brewing successfully promoted the growth of these beneficial aerobic microorganisms while actively discouraging harmful anaerobic pathogens, consistent with observations by Hegazi, El-Sayed & Abdel-Salam (2021) and Suhaimi and Ong (2020).

The measured increases in macronutrients (N, P, K) in the higher concentrations demonstrate highly efficient nutrient solubilization during fermentation. This outcome supports previous work by Adeolu, Aderonke, Opeyemi, and Ayomide (2020) and Bello, Hassan and Adebola (2018), who noted enhanced nutrient availability in aerated compost extracts made from poultry litter and cow dung. Moreover, the remarkable microbial load (up to 1.1×10^7 cfu mL⁻¹) is a critical factor, as microbial richness is directly linked to the tea's capacity for enhanced nutrient mineralization and plant disease suppression (Ntamwira, Mbeah, & Ngonda, 2022).

Growth Responses of Sorghum bicolor

The significant improvements in plant height, chlorophyll content, and tiller count with increased compost tea concentration clearly demonstrate its effectiveness as a bio-stimulant

for vegetative growth. These results mirror findings reported by Abiola, Olagunju and Alade (2019), who observed that compost tea increased maize height and leaf area by boosting the plant's nutrient uptake efficiency. The heightened chlorophyll content suggests that the nitrogen provided by the compost tea directly enhanced the crop's photosynthetic capacity, a mechanism commonly seen in leafy crops treated with similar organic liquid fertilizers (Olle, Al-Garni, & Hassan, 2021).

The beneficial microbial inoculants in the tea likely fostered better root growth and nutrient absorption by producing essential plant growth-promoting substances such as indole-3-acetic acid (IAA) and gibberellins (Zhao, Wang & Chen, 2022). Furthermore, the substantial increase in tillering can be attributed to this hormonal stimulation combined with improved soil structure, which in turn enhances soil aeration and water retention (Suarez-Estrella, Vargas-Garcia & Lopez, 2021).

Grain Yield Enhancement

The improved grain yield of Sorghum bicolor, particularly under the 75% compost tea treatment, provides strong evidence that the tea effectively delivered essential nutrients throughout the entire growing season. Similar yield boosts in cereal crops have been documented when compost tea was used as a supplemental foliar or soil fertilizer (El-Rahman, Abdel-Azeem, & Khalil, 2020; Nwachukwu, Onuoha, & Iwu, 2023). The yield gain achieved (3.85 t ha⁻¹) suggests that compost tea can deliver benefits comparable to those of synthetic fertilizers but without the associated negative environmental impact.

Compost teas function as effective slow-release nutrient sources, significantly reducing the leaching losses that are typical with mineral fertilizers (Bokhtiar & Sakurai, 2020). The sustained microbial activity within the soil continually aids nutrient recycling, ensuring a steady supply during the critical grain filling stage. These benefits, alongside the improved biological health of the soil, are highly consistent with the goals of sustainable agriculture, promoting reduced chemical inputs while successfully maintaining high productivity (FAO, 2020).

Corresponding author: Abdulrazaq Mohammed

✉ barkindo@fcezaria.edu.ng

Department of Department of Agricultural Education, Federal University of Education, Kaduna State, Zaria, Nigeria.

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Environmental and Agronomic Implications

These findings underscore compost tea's viability as an accessible biofertilizer alternative for smallholder farmers in northern Nigeria. The approach contributes to a circular bioeconomy by effectively recycling agricultural waste and mitigating environmental pollution (Aigbokhan, Osayimwen, & Enabulele, 2022). Given that Sorghum bicolor is inherently a drought-tolerant crop, integrating compost tea into its management regimen can significantly enhance its resilience against climate-induced soil degradation.

Furthermore, compost tea application stimulates beneficial rhizosphere interactions that lead to improved soil aggregate stability and better microbial carbon use efficiency (Chen, Wang, & Wang, 2021). These mechanisms are key to promoting long-term soil health and carbon sequestration, which are fundamental to sustainable agricultural intensification initiatives (Lal, 2020).

Comparison with Previous Studies

The current results are well-supported by several previous academic reports. Bello, Hassan, and Adebola (2018) and Osei, Amoako, and Twumasi (2019) both documented that compost tea derived from poultry manure successfully improved the yields of sorghum and maize compared to untreated control plots. Likewise, Nwankwo, Igwe, and Obasi (2021) reported impressive yield increases of 45% - 60% in cereals treated with various compost extracts. However, it is important to note that specific yield responses are always modulated by the compost source, brewing duration, and the dilution rate used (Pane, Palese, & Zaccardelli, 2016). My specific findings contribute new, valuable data regarding the successful application of compost tea under the unique Sudan Savanna conditions, emphasizing its proven dual role as both a nutrient delivery system and a powerful microbial bio-stimulant.

CONCLUSION

This study definitively demonstrates that compost tea, readily formulated from locally

available organic materials, significantly enhances the growth and grain yield of Sorghum bicolor under the challenging semi-arid conditions of Zaria, Nigeria. The application of higher concentrations (specifically 75%) provided superior nutrient availability, boosted beneficial microbial populations, and resulted in maximized vegetative growth, chlorophyll content, and final grain yield.

These results validate compost tea as a sustainable, cost-effective biofertilizer alternative to conventional chemical fertilizers, effectively promoting both soil fertility and plant productivity while supporting environmental conservation. The adoption of compost tea in sorghum cultivation offers a practical strategy for smallholder farmers to efficiently recycle agricultural waste, drastically reduce costly external inputs, and ultimately improve crop resilience in the face of climate change challenges.

Future research should focus on exploring the long-term impacts on soil health, refining the optimization of brewing and application protocols, and conducting thorough assessments of the economic feasibility for large-scale commercial compost tea production.

REFERENCES

- Abiola, S. S., Olagunju, T. D., & Alade, A. T. (2019). Effects of compost tea on growth, yield and nutritional composition of maize (*Zea mays* L.). *Journal of Crop Science and Biotechnology*, 22(3), 275-283.
- Adeolu, A. T., Aderonke, A. O., Opeyemi, A. O., & Ayomide, F. G. (2020). Effect of aerated compost tea on the growth and nutrient content of pepper (*Capsicum annum*). *Journal of Horticulture and Forestry*, 12(3), 85-91.
- Aigbokhan, E. I., Osayimwen, O. A., & Enabulele, S. A. (2022). Sustainable waste management for a circular bioeconomy in Nigeria: A review. *Waste Management*, 143, 16-29.
- AOAC. (2016). *Official methods of analysis* (20th ed.). Association of Official Analytical Chemists.
- Bello, N. J., Hassan, A. F., & Adebola, B. A. (2018). Growth and yield of maize as influenced by compost tea prepared from poultry manure. *Journal of Agricultural Research and Development*, 17(1), 1-12.

Corresponding author: Abdulrazaq Mohammed

✉ barkindo@fcezaria.edu.ng

Department of Department of Agricultural Education, Federal University of Education, Kaduna State, Zaria, Nigeria.

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- Bokhtiar, S. M., & Sakurai, K. (2020). Nitrogen mineralization from organic and chemical fertilizers for sustainable rice production. *Journal of Crop Science and Biotechnology*, 23(2), 115-125.
- Chen, Z., Wang, H., & Wang, Y. (2021). Compost application enhances soil aggregate stability and microbial carbon use efficiency in degraded land. *Soil Biology and Biochemistry*, 160, 108342.
- De Corato, U. (2019). Microbial biodiversity of compost and its role in plant disease suppression. *Frontiers in Microbiology*, 10, 1690.
- El-Rahman, F. H. A., Abdel-Azeem, F. H., & Khalil, M. A. M. (2020). Efficacy of compost tea as a biofertilizer and biocontrol agent on the growth and yield of cucumber. *Egyptian Journal of Biological Pest Control*, 30(1), 1-10.
- FAO. (2020). *World soil resources report: Status of the world's soil resources (SWSR)*. Food and Agriculture Organization of the United Nations.
- FMoH. (2016). *National Health Policy*. Federal Ministry of Health, Abuja, Nigeria.
- FMoH. (2018-2022). *Monitoring and Evaluation Plan for the Second National Strategic Health Development Plan*. Policy Vault. Africa.
- Hegazi, S. M., El-Sayed, S. A., & Abdel-Salam, A. M. (2021). Compost tea: A tool for sustainable agriculture and plant disease management. *Journal of Plant Pathology*, 103(2), 295-307.
- Jackson, M. L. (2017). *Soil chemical analysis (3rd ed.)*. Prentice Hall.
- Kim, K., Choi, J., & Lee, J. (2020). Comparison of aerated and non-aerated compost tea on the microbial community and plant growth promotion. *Applied Biological Chemistry*, 63(1), 1-9.
- Kolo, M. D., & Gwarzo, A. A. (2025). Influence of Health Management Information System in the Performance Primary Healthcare Services in Niger State. *Journal of Institute of Africa Higher Education Research and Innovation (IAHERI)*, 1(1).
- Lal, R. (2020). Digging deeper: A review of the role of compost in soil carbon sequestration. *Journal of Sustainable Agriculture and Environment*, 1(1), 1-15.
- Ntamwira, J., Mbeah, B., & Ngonda, B. (2022). Microbial diversity and functional properties of compost teas prepared from different organic wastes. *African Journal of Microbiology Research*, 16(2), 48-58.
- Nwachukwu, I. N., Onuoha, F. C., & Iwu, O. C. (2023). Harnessing local organic wastes for compost tea production: A sustainable approach for smallholder farmers in Nigeria. *Waste Management Bulletin*, 12(1), 20-35.
- Nwankwo, P. C., Igwe, J. C., & Obasi, N. A. (2021). Enhancing food production: The efficacy of compost extracts as liquid organic fertilizer in cereal crops. *Journal of Organic Agriculture and Environment*, 9(1), 55-68.
- Okonofua, F. (2013). The Primary Healthcare System in Nigeria. *African Journal of Reproductive Health*, 17(4).
- Olle, M., Al-Garni, S. M., & Hassan, S. M. (2021). Effects of organic liquid fertilizers on the growth and photosynthetic capacity of leafy vegetables. *Horticulturae*, 7(8), 263.
- Osei, B. O., Amoako, K. K., & Twumasi, Y. O. (2019). Efficacy of compost tea on growth and yield of maize and cowpea. *International Journal of Plant & Soil Science*, 29(4), 1-12.
- Pane, C., Palese, A. M., & Zaccardelli, M. (2016). Compost tea for sustainable agriculture: Constraints and opportunities. *Applied Soil Ecology*, 103, 1-13.
- Paul, S. O. (2025). An Appraisal of Primary Health Care Policy Implementation in Nigerian Rural and Semi-Urban Sector after Four Decades. *PanAfrican Journal of Governance and Development*, 1(1), 112-140.
- Suarez-Estrella, F., Vargas-Garcia, M. D., & Lopez, M. J. (2021). Compost tea as a plant growth stimulator: Effects on soil properties and crop productivity. *Agronomy*, 11(5), 980.
- Suhaimi, H., & Ong, S. K. (2020). Characterization of microbial populations in aerated compost tea and its effect on plant growth. *Journal of Applied Microbiology*, 129(4), 931-942.
- Zhao, Q., Wang, H., & Chen, J. (2022). Production of plant growth-promoting hormones by microorganisms in compost tea and their role in improving crop yield. *Microbiological Research*, 255, 126938.

Corresponding author: Abdulrazaq Mohammed

✉ barkindo@fchezaria.edu.ng

Department of Department of Agricultural Education, Federal University of Education, Kaduna State, Zaria, Nigeria.

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