



EVALUATION OF COMPOSTED CABBAGE (*Brassica oleracea* L.) AS A PLANT GROWING MEDIA FOR HORTICULTURAL PRODUCTION

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Abstract

The high costs and limited availability of conventional plant-growing media in Zambia and sub-Saharan Africa pose significant barriers to sustainable horticultural production. This study evaluates composted cabbage waste as a cost-effective and sustainable alternative for horticultural crop cultivation. Experiments at Mulungushi University, Zambia, compared composted cabbage with commercial Hygromix-Poliprop using cabbage, cucumber, tomato, and green pepper as test materials. Composted cabbage substantially increased emergence rates in cabbage (94.44%) and tomato (87.5%), while commercial media were more effective for cucumber and green pepper. The sequence of crop emergence favoured composted cabbage, with cabbage emerging first, followed by cucumber, tomato, and green pepper, suggesting favourable conditions for early establishment. Composted cabbage also improved biomass accumulation, with cabbage showing the highest dry matter accumulation (51.39%) in the composted media, indicating its potential to support robust growth and productivity. Root length and seedling vigour exhibited similar trends, with composted cabbage benefiting cabbage and tomato. A benefit-cost analysis yielded a cost-benefit ratio of two (2) for composted cabbage. These findings demonstrate that composted cabbage is a viable and sustainable alternative to commercial media for certain crops, supporting the circular bioeconomy through agricultural waste recycling. Further research should refine composting processes and investigate broader applications to enhance its utility as a universal growth medium.

Key words: *bioeconomy, horticulture, seedling establishment, agricultural waste recycling, economic viability.*

INTRODUCTION

Horticultural crops such as cabbage (*Brassica oleracea*), tomato (*Solanum lycopersicum*), cucumber (*Cucumis sativus*), and green pepper (*Capsicum annuum*) are essential to both global and local economies, serving as key sources of income and nutrition. In Sub-Saharan Africa (SSA), these crops play a critical role in food security by providing essential vitamins (K, A, and C) and minerals (calcium and potassium) necessary for human health (Lal, 2021; Mallick, 2022). The agricultural sector employs the majority of the population in the SSA, making it a cornerstone of the regional economy. Smallholder farmers are primarily responsible for horticultural production, thereby ensuring food availability and economic stability (Mweshi

et al., 2022). However, small-scale farmers face significant obstacles to production efficiency and sustainability, particularly due to the high cost and limited availability of commercial growing media. Addressing these challenges is crucial for advancing sustainable agricultural practices that enhance crop yields and profitability.

Reliance on imported or expensive conventional growing media prevents many farmers from achieving optimal yields due to prohibitive costs (Mariotti et al., 2020). Although commercial growing media offer beneficial properties for plant growth, their high cost restricts access for smallholder farmers, leading to suboptimal seedling quality, reduced yields, and diminished farm profitability (Dunn et al., 2021).

There is a critical need for cost-effective, locally sourced alternatives to support sustainable agricultural development. Implementing such alternatives could reduce input costs and enhance soil fertility, providing farmers with accessible growth media that meet plant growth requirements. Sub-Saharan Africa produces substantial agricultural and organic waste, largely due to extensive agricultural activities and a high proportion of organic material (Debrah et al., 2022). Organic materials account for nearly 57% of the region's waste, predominantly from agricultural sources. However, limited recycling infrastructure and technology hinder the effective conversion of this waste into valuable resources.

To address these challenges, research is focusing on locally available alternatives such as bark and wood fibre, which have the potential to reduce costs and improve sustainability (Gruda, 2019). Composted agricultural waste, particularly cabbage leaves, represents an innovative and sustainable alternative with both economic and environmental benefits. In SSA, post-harvest losses of perishable crops can reach 20% to 50%, resulting in a surplus of agricultural waste suitable for composting into growth media (FAO, 2019). Recycling this waste into compost supports the circular bioeconomy by prioritizing waste minimization and resource efficiency through the continuous cycling of organic materials within the agricultural system (Khan & Ali, 2022). This approach reduces reliance on expensive commercial substrates and addresses environmental concerns associated with synthetic growing media. For instance, the extraction of peat moss for commercial media contributes to environmental degradation and biodiversity loss (De Corato, 2020).

Composted cabbage has shown considerable potential as a growth medium. Its composition improves soil structure, enhances microbial activity, and supplies essential nutrients at a significantly lower cost than commercial alternatives (Pergola et al., 2020; Siedt et al., 2021). These attributes may make it particularly advantageous to smallholder farmers who encounter financial barriers to accessing imported or commercial media. Additionally, the water-retentive properties of composted cabbage may be especially valuable in arid and semi-arid regions of SSA, where water conservation is critical. This characteristic is vital for promoting resilient agricultural practices in

SSA, a region projected to experience severe droughts and increased vulnerability due to climate change (Mphande et al., 2023).

Previous research has demonstrated that compost enhances key growth parameters, including seedling vigor, root development, and moisture retention (El Moussaoui et al., 2024; Rasool et al., 2021). Organic composts release volatile organic compounds (VOCs) during decomposition, which enhance enzyme activity and regulate plant hormones, thereby supporting improved plant growth (Dhamodharan et al., 2019). These physiological benefits are particularly important for smallholder farmers, who require robust and resilient seedlings to maximize productivity under resource-constrained conditions. Additionally, composted cabbage waste might reduce reliance on expensive external inputs, increasing on-farm self-sufficiency and supporting environmentally sustainable agricultural practices (Koul et al., 2022; Manea et al., 2024).

Beyond environmental benefits, composted cabbage can be economically feasible to smallholder farmers with limited profit margins. Horticultural crops generally involve high production costs due to substantial input requirements; utilizing locally produced compost can significantly reduce these expenses. Converting agricultural waste into compost allows farmers to transform disposal costs into valuable resources, creating a closed-loop system that benefits local economies and promotes environmental sustainability. This strategy aligns with circular bioeconomy principles, which emphasize repurposing agricultural waste to minimize environmental impact and improve soil health (Negi et al., 2021).

Despite the potential of cabbage compost, knowledge gaps persist regarding its effectiveness for different crops. Most research on composted agricultural waste has focused on mixtures derived from diverse organic sources, such as crop residues, municipal waste, or animal manure, with limited studies specifically investigating cabbage-based compost as a growing medium (Martins et al., 2023). Furthermore, research tailored to Sub-Saharan Africa, where resource constraints and limited access to commercial inputs underscore the need for local alternatives, remains limited (Langyintuo, 2020).

This study therefore investigates the potential of composted cabbage as a sustainable and cost-effective alternative to conventional

growing media. Specifically, it evaluates its effects on seedling emergence, stem and root development, seedling vigour, and dry matter accumulation in four horticultural crops; cabbage, tomato, cucumber, and green pepper. These crops were selected due to their economic importance, differing growth characteristics, and nutrient requirements, allowing for a comprehensive assessment of composted cabbage across diverse crop types. It was hypothesized that composted cabbage would perform comparably or better

than commercial media in promoting seedling growth and biomass accumulation, while offering a more affordable and environmentally sustainable option for smallholder farmers. By addressing the current knowledge gaps in single-source compost research, particularly cabbage-based compost, this contributes to the development of localized, circular bioeconomy solutions that enhance sustainable horticultural production in Sub-Saharan Africa.

MATERIALS AND METHODS

Study Location and Nutrient Analysis

The study was conducted in a greenhouse at Mulungushi University, Kabwe, Zambia (27°9'E, 14°30'S, 672.04 m above sea level). Composted cabbage waste was used in the experiments and analyzed at the Zambia Agriculture Research

Institute (ZARI) in Mount Makulu, Chilanga, for its nutrient content. The nutrient composition analysis (Table 1) included organic carbon, essential minerals, and trace elements necessary for plant growth and development.

Table 1. Nutrient analysis of composted cabbage.

Nutrient	Results
Organic Carbon (Org C %)	6.336
Phosphorus (P %)	0.120967
Nitrogen (N %)	0.3
Calcium (Ca %)	1.4629
Magnesium (Mg %)	0.27
Potassium (K %)	0.4
Sodium (Na ppm)	0.397
Copper (Cu ppm)	1.814
Manganese (Mn ppm)	25.47
Iron (Fe ppm)	422.89
Zinc (Zn ppm)	21.29

Composting Procedure

Cabbage waste was combined with sawdust at a carbon-to-nitrogen (C/N) ratio of 25:1. The compost mixture was layered to enhance aeration and moisture retention, with the compost pile turned regularly every seven days over a 60-day period. Maturity was assessed visually by darkening of the compost and the absence of offensive odours.

Experimental Design

The study employed a split-plot design (SPD) with six replications. Seedling trays with 200 cells served as the main plots, each containing two growing media treatments: composted cabbage

(experimental medium) and a commercial growing medium (Hygromix-Poliprop) as the control. Each tray represented an experimental unit and was subdivided into four subplots corresponding to the test crops: cabbage (*Brassica oleracea*), cucumber (*Cucumis sativus*), tomato (*Solanum lycopersicum*), and green pepper (*Capsicum annuum*). Randomization of treatments within each replication was achieved using a completely randomized block design (CRBD) to minimize positional bias. Each subplot consisted of 24 seedlings per crop. Seeds were sown at a depth of 5 mm and irrigated twice daily with 960 ml of water per tray. No fertilizers,

pesticides, or fungicides were applied during the experiment. The two experiments differed only in timing and batch variation: Experiment 2 was conducted to validate results from Experiment 1 and assess possible batch variability in the

Data Collection

Emergence Percentage:

Emergence percentage was calculated using the formula below (Carlson & Clay, 2016) :

Emergence % = (Seeds emerged/ Seeding rate) * 100%

Stem length and root length were measured using a ruler 14 days after seedling emergence on three randomly selected seedlings per sub-plot.

Seedling Vigour Index (SVI): SVI was calculated as follows (Abdul-Baki & Anderson, 1973):

Seedling length = Shoot length + root length

Vigour Index = Emergence % * Seedling length

Dry Matter Accumulation: Fifteen plants were harvested on the 14th day, washed, and dried in an oven at 60°C until constant weight. Dry matter accumulation was calculated using the formula:

Dry matter accumulation (%) = Dry weight/ Fresh weight * 100 (Bodnár et al., 2018).

commercial media. Substrate physical properties such as bulk density, porosity, pH, electrical conductivity (EC), and water-holding capacity were not measured, representing a limitation to be addressed in future work.

Statistical Analysis

Data were analysed using ANOVA in Jamovi (version 2.3.28). Tukey's post hoc test was employed to separate means at a significance level of $\alpha = 0.05$. Assumptions of normality and homogeneity of variance were checked prior to analysis.

Economic Analysis: A benefit-cost ratio (BCR) was calculated to evaluate the financial viability of using composted cabbage as a growth medium, using the formula:

Benefit-Cost Ratio (BCR) = $\sum (B_t / (1 + r)^t) / \sum (C_t / (1 + r)^t)$, where B represents the benefits, C the costs, the time in years, and r the discount rate (Naseem, 2011).

All financial data were adjusted to 2024 values using a discount rate of 10%.

RESULTS AND DISCUSSION

Table 2. Summary of effects of composted cabbage and commercial growth media on seedling growth parameters.

Variable	Source	Experiment 1 (Means)	Experiment 1 (p-value)	Experiment 2 (Means)	Experiment 2 (p-value)
Emergence Percentage (%)	Crop	2.31	0.351	51.40	<0.001
	Media Type	4.93	0.013	98.03	<0.001
	Crop * Media Type	5.03	0.011	28.02	0.007
Stem Length (mm)	Crop	10.83	<0.001	5.56	<0.001
	Media Type	1.40	0.571	19.73	<0.001
	Crop * Media Type	3.04	0.217	6.92	<0.001
Root Length (mm)	Crop	72.09	<0.001	57.32	<0.001
	Media Type	3.61	0.818	26.51	0.016
	Crop * Media Type	10.84	0.695	11.31	0.343
Seedling Vigour Index	Crop	15.89	<0.001	8366.60	<0.001
	Media Type	1.27	0.751	11224.97	<0.001
	Crop * Media Type	3.37	0.544	1688.19	0.27
Dry Matter Accumulation (%)	Crop	25.71	0.133	41.11	<0.001
	Media Type	18.38	0.056	27.92	0.02
	Crop * Media Type	52.06	<0.001	5.96	0.848

The results from both experiments demonstrated the potential of composted cabbage as an alternative to conventional commercial media for growth.

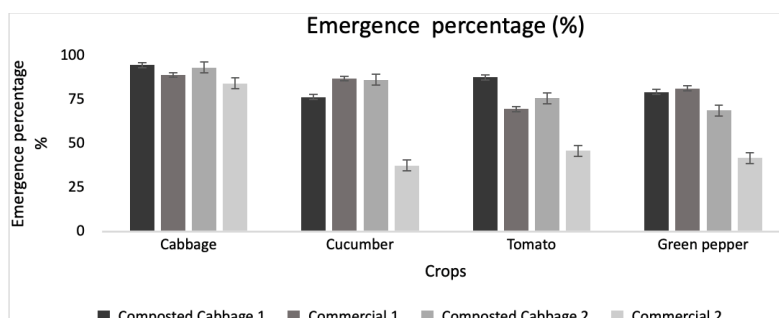


Figure 1. Effect of growing media on emergence percentage of horticultural crops. Error bars represent standard deviation ($p < 0.05$).

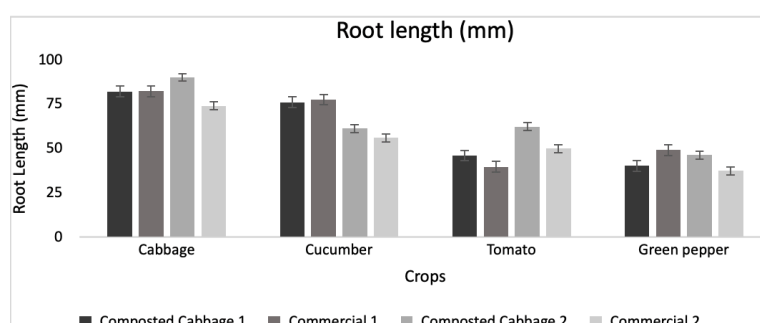


Figure 2. Effect of growing media on root length of horticultural crops. Error bars represent standard deviation ($p < 0.05$).

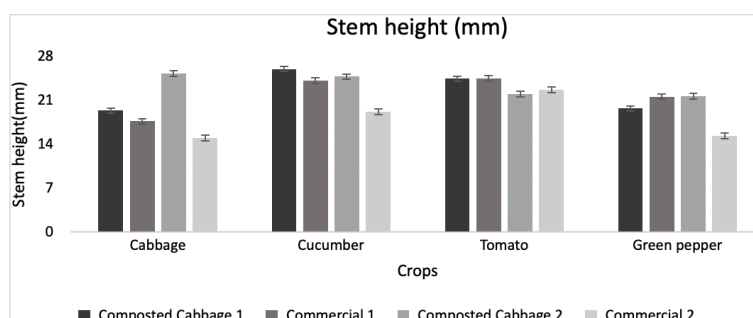


Figure 3. Effect of growing media on stem height of horticultural crops. Error bars represent standard deviation ($p < 0.05$).

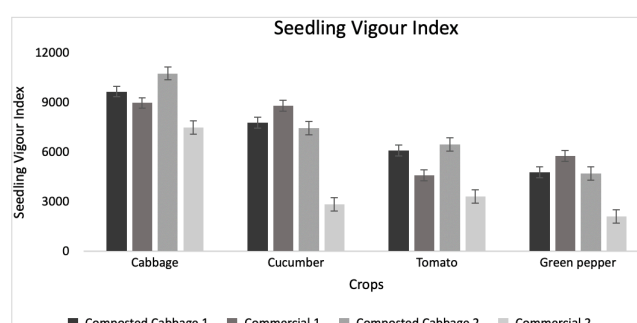


Figure 4. Effect of growing media on seedling vigour index of horticultural crops. Error bars represent standard deviation ($p < 0.05$).

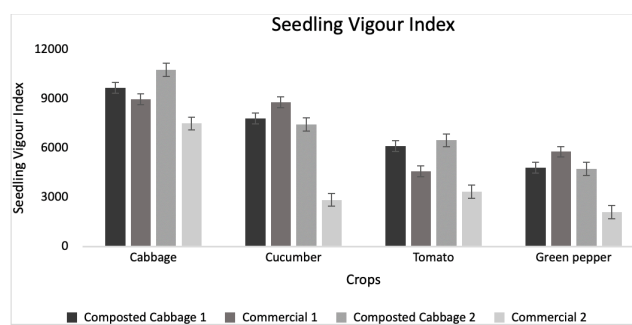


Figure 5. Effect of growing media on dry matter accumulation percentage of horticultural crops. Error bars represent standard deviation ($p < 0.05$).

The results of this study, summarized in Table 2, present the comparative effects of composted cabbage and commercial growing media on seedling emergence, root length, stem height, seedling vigor index, and dry matter accumulation (DMA%) for four horticultural crops: cabbage (*Brassica oleracea*), tomato (*Solanum lycopersicum*), cucumber (*Cucumis sativus*), and green pepper (*Capsicum annuum*). Two experiments were conducted to validate the reproducibility of findings, and variations between trials were noted, particularly in commercial media performance, which may be attributed to differences in substrate batches or storage conditions. All parameters were influenced by crop type, media type, and their interactions to varying degrees.

Seedling emergence percentage differed significantly across both crop species and growing media. Composted cabbage consistently supported higher emergence in cabbage and tomato, with mean rates of 94.44% and 87.5%, respectively, in the first trial, and slightly lower but still strong rates of 93.06% and 75.69% in the second. These results underscore the stability of composted cabbage as a reliable growth medium across experiments. The enhanced emergence under composted cabbage can be attributed to its rich organic matter and nutrient profile, particularly its higher nitrogen and phosphorus availability, which improve early germination and root initiation (Urrea et al., 2019; Sayara et al., 2020). The physical properties of the compost, including superior moisture retention and aeration, may also have contributed to more uniform germination. Similar findings were reported by (Ronga et al., 2021), who observed that compost-based substrates support more consistent emergence

due to their porous structure and higher cation exchange capacity. In contrast, cucumber and green pepper showed better emergence in the commercial medium during the first experiment, particularly with rates of 86.8% and 81.25%, respectively. This may be due to the balanced nutrient composition and stable pH of commercial media, which favour the germination of more nutrient-sensitive species (Gruda, 2019; Prasad et al., 2019). However, emergence rates declined sharply in the second commercial trial, possibly due to batch variability or reduced microbial activity over storage (Salisu et al., 2020). The general trend observed across both trials, where cabbage emerged first followed by cucumber, tomato, and green pepper in composted cabbage, indicates that the medium created favourable physical and biochemical conditions for early seedling establishment. Early emergence in cabbage, in particular, reflects its lower temperature threshold and higher responsiveness to organic matter-rich substrates (Sharma et al., 2022). With climate change driven droughts expected to increase in frequency and intensity (Mphande et al., 2023, 2024), composted cabbage has potential to reduce irrigation frequency, thereby contributing to climate-smart vegetable production. In contrast, the delayed emergence observed in the commercial media could be related to less favourable moisture conditions and lower microbial activity, both of which are critical for early seedling development (Chrysargyris et al., 2020). This sequential emergence pattern suggests that composted cabbage can serve as a versatile medium across various crop species. For example, for neglected and underutilised indigenous vegetables such as *Cleome gynandra*, which have high

micronutrient density but poor germination and emergence patterns (Mphande, 2025), and are therefore difficult to propagate, composted cabbage may help overcome this constraint and unlock their production potential.

Root length, a key indicator of seedling vigour and nutrient uptake capacity, also varied among treatments. In cabbage and tomato, root development was markedly superior in composted cabbage, with the longest roots recorded in the Composted Cabbage 2 treatment (90.11 mm and 62.22 mm, respectively). These results suggest that composted cabbage enhances root elongation through improved soil porosity and gradual nutrient release (Elshony et al., 2019; Shaji et al., 2021). The presence of humic substances and beneficial microbial activity likely contributed to increased nutrient solubilization and root proliferation. This observation aligns with the findings of Jain & Kalamdhad, (2020), who demonstrated that organic matter from compost enhances root growth by improving aeration and supporting microbial symbiosis. Conversely, cucumber and green pepper displayed longer roots in commercial media (77.56 mm and 49.06 mm, respectively), indicating that these species may respond better to the more stable and fine-textured structure of commercial substrates. These differences could be linked to species-specific root architecture and nutrient preferences, as previously emphasized by Prince et al., 2019 and Wen et al., (2019), who noted that genetic traits strongly influence root morphology. The lower root length observed in the second commercial trial may again reflect inconsistencies in substrate quality, underscoring the importance of maintaining uniform media composition across production batches.

Stem height exhibited similar trends, with composted cabbage treatments producing taller seedlings in cabbage (25.28 mm) and tomato (22.0 mm), compared to commercial media. This suggests that composted cabbage supports early vegetative growth through enhanced nutrient availability, particularly nitrogen, which is crucial for stem elongation (Solaiman et al., 2019). The slight decline in cucumber stem height observed in the second composted trial (24.78 mm compared to 26.0 mm in the first) may reflect differences in compost maturity

affecting nutrient release and microbial activity (Yang & Zhang, 2022). Green pepper showed marginally higher stem heights in commercial media, suggesting a crop-specific response to nutrient balance and substrate texture (Abdel-Razzak et al., 2019). The significant effects observed for crop type and media type ($p < 0.001$) in Experiment 2 confirm that growth responses were influenced by both genetic and substrate-related factors.

The seedling vigor index (SVI), which integrates germination and growth metrics, further demonstrated the distinct advantages of composted cabbage for certain crops. Cabbage and tomato recorded the highest SVI values in Composted Cabbage 2 (10,764.81 and 6,465.97, respectively), emphasizing the medium's capacity to promote robust early growth. These findings support those of El Moussaoui et al. (2024), who reported that organic compost enhances vigor through improved root-shoot balance and water retention. In contrast, cucumber and green pepper performed better in the commercial medium, likely due to its optimized pH and nutrient ratios that better suit their physiological requirements (Kirkby, 2023). The superior SVI in cabbage and tomato under composted treatments indicates that organic matter-rich media enhance early seedling resilience, a key advantage for smallholder farmers seeking to establish healthy transplants with limited resources.

Dry matter accumulation (DMA%) results reflected similar patterns. Composted cabbage promoted the highest biomass accumulation in cabbage (51.39%), indicating efficient nutrient uptake and photosynthetic activity under this medium. This outcome aligns with findings by Lamichaney et al., (2022), who reported that compost-based substrates improve total biomass due to their sustained nutrient release. Conversely, cucumber and green pepper recorded higher DMA% in commercial media, with 37.04% and 62.04%, respectively, suggesting that these crops benefit more from the nutrient stability and aeration provided by the commercial substrate. Tomato showed moderate performance across both media, reflecting its intermediate nutrient demand. These variations suggest that composted cabbage is best suited for leafy and fruiting crops with moderate nutrient requirements, whereas

commercial media may be more effective for nutrient-sensitive crops like cucumber and green pepper.

Overall, the findings demonstrate that composted cabbage is a viable and sustainable alternative to commercial media for specific horticultural crops. Its superior performance in cabbage and tomato highlights its potential to reduce reliance on costly commercial substrates while recycling agricultural waste into productive use. For smallholder farmers in Zambia and similar regions, this offers a dual benefit: cost savings and improved

environmental sustainability. However, the lack of data on physical substrate properties (bulk density, porosity, water-holding capacity, pH, and EC) is acknowledged as a limitation. Future studies should incorporate these parameters to better understand the mechanisms driving crop-specific responses. Despite these limitations, the consistent performance of composted cabbage across both experiments, alongside its economic viability (BCR = 2), underscores its potential as an affordable and environmentally sound growing medium for sustainable horticultural production.

CONCLUDING REMARKS

To advance the application of composted cabbage as a growth medium, future research should focus on optimizing the composting process for cabbage waste, ensuring consistent nutrient availability, and improving quality. Studies investigating microbial strains such as *Bacillus subtilis*, *Pseudomonas fluorescens*, or the use of *Eisenia fetida* in vermicomposting could offer insights into nutrient stability and enhanced growth properties (Das & Deka, 2021; Wai et al., 2022). Evaluating composting methods such as anaerobic digesters or windrow systems, and their effects on maturity, nutrient profile, and stability, will be essential.

Another key area is the interaction between composted cabbage and organic or synthetic fertilizers. Understanding nutrient synergies and antagonisms, especially those related to nitrogen and phosphorus availability, would help tailor balanced nutrient profiles to specific crops. Research should also assess how these interactions influence soil health and sustainability, particularly under resource-limited conditions. The effectiveness of composted cabbage should be explored across a wider range of horticultural crops, including leafy greens, root vegetables, and fruiting plants, in diverse agro-climatic zones. Testing climate-resilient crops, such as spinach, carrots, or bell peppers, could reveal their versatility across various farming systems. Aligning studies with regional cropping patterns would establish composted cabbage as an adaptable, resilient medium.

Long-term field trials are necessary to evaluate the impact of composted cabbage on

productivity, soil health, and microbial dynamics. Monitoring over multiple seasons would clarify the effects on soil properties and nutrient cycling, informing strategies for sustainable use in both smallholder and large-scale systems. This would also help quantify long-term benefits such as reduced inputs and yield improvements. Evaluating the economic feasibility of on-farm compost production could support the adoption of smallholders. Successful systems in India and Brazil can serve as models (Shinde et al., 2022; van der Velden et al., 2022). Adapting them locally, alongside training, could scale adoption as a low-cost alternative to commercial media.

Innovative technologies, such as compost tumblers, aerated piles, or digesters, may reduce nutrient loss, accelerate decomposition, and enhance quality. Researching these tools could help retain nutrients like nitrogen and potassium while minimizing contamination, enhancing the compost's environmental and agronomic value. Standardizing compost quality protocols is also vital. Parameters such as the carbon-to-nitrogen ratio, microbial activity, moisture, and heavy metals should be harmonized to ensure safety and optimal performance. Leveraging existing frameworks, such as ISO 17025 or European Compost Network standards, could enable consistent and reliable assessments across regions (Miguel et al., 2021; Stehouwer et al., 2022).

This study demonstrates that composted cabbage can function as an effective and sustainable alternative to traditional growing media. Across multiple growth parameters, composted cabbage consistently supported

robust seedling development. These results underscore its potential to facilitate sustainable and cost-effective seedling production, particularly for small-scale and emerging farmers. Additionally, composted cabbage offers a viable approach for recycling agricultural waste into valuable resources, thereby contributing

to sustainable farming practices and circular bioeconomy frameworks. Future research should further investigate the broader applicability of composted cabbage in diverse cropping systems and agro-climatic zones, as well as its integration into smallholder farming practices.

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REFERENCES

- A Abdel-Razzak, H., Alkoik, F., Rashwan, M., Fulleros, R., & Ibrahim, M. (2019). Tomato waste compost as an alternative substrate to peat moss for the production of vegetable seedlings. *Journal of Plant Nutrition*, 42(3), 287–295. <https://doi.org/10.1080/01904167.2018.1554682>
- Abdul-Baki, A. A., & Anderson, J. D. (1973). Vigor Determination in Soybean Seed by Multiple Criteria 1. *Crop Science*, 13(6), 630–633. <https://doi.org/10.2135/cropsci1973.0011183X001300060013x>
- Bodnár, K. B., Nasir Mousavi, S. M., & Nagy, J. (2018). Evaluation of dry matter accumulation of maize (*Zea mays* L.) hybrids. *Acta Agraria Debreceniensis*, 74, 35–41. <https://doi.org/10.34101/actaagrar/74/1661>
- Carlson, C. G., & Clay, D. E. (2016). Estimating Corn Seedling Emergence and Variability. November.
- Chrysargyris, A., Prasad, M., Kavanagh, A., & Tzortzakos, N. (2020). Biochar Type, Ratio, and Nutrient Levels in Growing Media Affects Seedling Production and Plant Performance. *Agronomy*, 10(9), 1421. <https://doi.org/10.3390/agronomy10091421>
- Das, D., & Deka, H. (2021). Vermicomposting of harvested waste biomass of potato crop employing *Eisenia fetida*: changes in nutrient profile and assessment of the maturity of the end products. *Environmental Science and Pollution Research*, 28(27), 35717–35727. <https://doi.org/10.1007/s11356-021-13214-z>
- De Corato, U. (2020). Agricultural waste recycling in horticultural intensive farming systems by on-farm composting and compost-based tea application improves soil quality and plant health: A review under the perspective of a circular economy. *Science of The Total Environment*, 738, 139840. <https://doi.org/10.1016/j.scitotenv.2020.139840>
- Debrah, J. K., Teye, G. K., & Dinis, M. A. P. (2022). Barriers and Challenges to Waste Management Hindering the Circular Economy in Sub-Saharan Africa. *Urban Science*, 6(3). <https://doi.org/10.3390/urbansci6030057>
- Dhamodharan, K., Varma, V. S., Veluchamy, C., Pugazhendhi, A., & Rajendran, K. (2019). Emission of volatile organic compounds from composting: A review on assessment, treatment and perspectives. *Science of The Total Environment*, 695, 133725. <https://doi.org/10.1016/j.scitotenv.2019.133725>
- Dunn, B., Bizhen, H., & Dharti, T. (2021). Soilless Growing Mediums. *Division of Agricultural Sciences and Natural Resources*, October, 1–7.
- El Moussaoui, H., Idardare, Z., & Bouqbis, L. (2024). The Link Between High Vigor and Physiological Parameters of Alfalfa Grown in Two Fertilization Modes: Classic Based on Chemical Fertilizers and Manure and Modern Based on Biocompost and Biochar Under and Without Deficit Water. *Journal of Soil Science and Plant Nutrition*. <https://doi.org/10.1007/s42729-024-01677-1>
- Elshony, M., Farid, I., Alkamar, F., Abbas, M., & Abbas, H. (2019). Ameliorating a sandy soil using biochar and compost amendments and their implications as slow release fertilizers on plant growth. *Egyptian Journal of Soil Science*, 0–0. <https://doi.org/10.21608/ejss.2019.12914.1276>
- FAO. (2019). The State of Food and Agriculture. Moving forward on food loss and waste reduction. In *Chemistry and Industry* (London) (Vol. 83, Issue 2). https://doi.org/10.1002/cind.832_8.x
- Gruda, N. (2019). Increasing Sustainability of Growing Media Constituents and Stand-Alone Substrates in Soilless Culture Systems. *Agronomy*, 9(6), 298. <https://doi.org/10.3390/agronomy9060298>
- Jain, M. S., & Kalamdhad, A. S. (2020). Soil revitalization

- via waste utilization: Compost effects on soil organic properties, nutritional, sorption and physical properties. *Environmental Technology & Innovation*, 18, 100668. <https://doi.org/10.1016/j.eti.2020.100668>
- Khan, F., & Ali, Y. (2022). Moving towards a sustainable circular bio-economy in the agriculture sector of a developing country. *Ecological Economics*, 196, 107402. <https://doi.org/10.1016/j.ecolecon.2022.107402>
- Kirkby, E. A. (2023). Introduction, definition, and classification of nutrients. In *Marschner's Mineral Nutrition of Plants* (pp. 3–9). Elsevier. <https://doi.org/10.1016/B978-0-12-819773-8.00016-2>
- Koul, B., Yakoob, M., & Shah, M. P. (2022). Agricultural waste management strategies for environmental sustainability. *Environmental Research*, 206, 112285. <https://doi.org/10.1016/j.envres.2021.112285>
- Lal, B. (2021). A review study on tomato and its health benefits. *Asian Journal of Research in Social Sciences and Humanities*, 11(12), 197–202. <https://doi.org/10.5958/2249-7315.2021.00337.3>
- Lamichaney, A., Tewari, K., Katiyar, P. K., Parihar, A. K., Pratap, A., & Singh, F. (2022). Implications of exposing mungbean (*Vigna radiata* L.) plant to higher CO₂ concentration on seed quality. *International Journal of Biometeorology*, 66(12), 2425–2431. <https://doi.org/10.1007/s00484-022-02366-3>
- Langyintuo, A. (2020). Smallholder Farmers' Access to Inputs and Finance in Africa. In *The Role of Smallholder Farms in Food and Nutrition Security* (pp. 133–152). Springer International Publishing. https://doi.org/10.1007/978-3-030-42148-9_7
- Mallick, P. K. (2022). Evaluating potential importance of cucumber (*Cucumis sativus* L. -Cucurbitaceae): A brief review. *International Journal of Applied Sciences and Biotechnology*, 10(1), 12–15. <https://doi.org/10.3126/ijasbt.v10i1.44152>
- 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. <https://doi.org/10.3390/su16156329>
- Mariotti, B., Martini, S., Raddi, S., Tani, A., Jacobs, D. F., Olié, J. A., & Maltoni, A. (2020). Coconut Coir as a Sustainable Nursery Growing Media for Seedling Production of the Ecologically Diverse Quercus Species. *Forests*, 11(5), 522. <https://doi.org/10.3390/f11050522>
- Martins, T., Machado, R., Alves-Pereira, I., Ferreira, R., & Gruda, N. (2023). Coir-Based Growing Media with Municipal Compost and Biochar and Their Impacts on Growth and Some Quality Parameters in Lettuce Seedlings. *Horticulturae*, 9(1), 105. <https://doi.org/10.3390/horticulturae9010105>
- Miguel, A., Moreira, R., & Oliveira, A. (2021). ISO/IEC 17025: History and introduction of concepts. *Química Nova*. <https://doi.org/10.21577/0100-4042.20170726>
- Mphande, W. (2025). Research gaps in neglected indigenous vegetables in sub-Saharan Africa: A roadmap to mainstreaming. 1–13.
- Mphande, W., Farrell, A. D., & Kettlewell, P. S. (2023). Commercial uses of antitranspirants in crop production: A review. *Outlook on Agriculture*, 52(1), 3–10. <https://doi.org/10.1177/00307270231155257>
- Mphande, W., Farrell, A. D., Vickers, L. H., Grove, I. G., & Kettlewell, P. S. (2024). Yield improvement with antitranspirant application in droughted wheat associated with both reduced transpiration and reduced abscisic acid. *Journal of Agricultural Science*. <https://doi.org/10.1017/S0021859624000157>
- Mweshi, M., Mwitwa, J., Ng'andwe, P., Phiri, D., Kapembwa, C., Devinish, A., Xiaoting, H.-J., Franks, P., & Adolph, B. (2022). Contextual analysis of agriculture in Zambia: review of the agricultural sector in Zambia conducted in 2018–19 as a contextual analysis for the Sentinel project. May. www.sentinel-gcrf.org
- Naseem, A. (2011). Benefit-Cost Assessment of Different Homestead Vegetable Gardening on Improving Household Food and Nutrition Security in Rural Bangladesh Md Asaduzzaman. 1–25.
- Negi, S., Hu, A., & Kumar, S. (2021). Circular Bioeconomy: Countries' Case Studies. In *Biomass, Biofuels, Biochemicals* (pp. 721–748). Elsevier. <https://doi.org/10.1016/B978-0-12-821878-5.00008-8>
- Pergola, M., Persiani, A., Pastore, V., Palese, A. M., D'Adamo, C., De Falco, E., & Celano, G. (2020). Sustainability Assessment of the Green Compost Production Chain from Agricultural Waste: A Case Study in Southern Italy. *Agronomy*, 10(2), 230. <https://doi.org/10.3390/agronomy10020230>
- Prasad, M., Chrysargyris, A., McDaniel, N., Kavanagh, A., Gruda, N. S., & Tzortzakakis, N. (2019). Plant Nutrient Availability and pH of Biochars and Their Fractions, with the Possible Use as a Component in a Growing Media. *Agronomy*, 10(1), 10. <https://doi.org/10.3390/agronomy10010010>
- Prince, S. J., Valliyodan, B., Ye, H., Yang, M., Tai, S., Hu, W., Murphy, M., Durnell, L. A., Song, L., Joshi, T., Liu, Y., Van de Velde, J., Vandepoele, K., Grover Shannon, J., & Nguyen, H. T. (2019).

- Understanding genetic control of root system architecture in soybean: Insights into the genetic basis of lateral root number. *Plant, Cell & Environment*, 42(1), 212–229. <https://doi.org/10.1111/pce.13333>
- Rasool, M., Akhter, A., Soja, G., & Haider, M. S. (2021). Role of biochar, compost and plant growth promoting rhizobacteria in the management of tomato early blight disease. *Scientific Reports*, 11(1), 6092. <https://doi.org/10.1038/s41598-021-85633-4>
- Ronga, D., Vitti, A., Zaccardelli, M., Pane, C., Caradonia, F., Cardarelli, M., Colla, G., & Roupheal, Y. (2021). Root Zone Management for Improving Seedling Quality of Organically Produced Horticultural Crops. *Agronomy*, 11(4), 630. <https://doi.org/10.3390/agronomy11040630>
- Salisu, M. A., Sulaiman, Z., & Samad, M. Y. A. (2020). Growth and biomass yield of rubber seedlings grown on soilless and soil-based media. *Bangladesh Journal of Botany*, 49(2), 229–236. <https://doi.org/10.3329/bjb.v49i2.49296>
- Sayara, T., Basheer-Salimia, R., Hawamde, F., & Sánchez, A. (2020). Recycling of Organic Wastes through Composting: Process Performance and Compost Application in Agriculture. *Agronomy*, 10(11), 1838. <https://doi.org/10.3390/agronomy10111838>
- Shaji, H., Chandran, V., & Mathew, L. (2021). Organic fertilizers as a route to controlled release of nutrients. In *Controlled Release Fertilizers for Sustainable Agriculture* (pp. 231–245). Elsevier. <https://doi.org/10.1016/B978-0-12-819555-0.00013-3>
- Sharma, S., Singh, V., Tanwar, H., Mor, V. S., Kumar, M., Punia, R. C., Dalal, M. S., Khan, M., Sangwan, S., Bhuker, A., Dagar, C. S., Yashveer, S., & Singh, J. (2022). Impact of High Temperature on Germination, Seedling Growth and Enzymatic Activity of Wheat. *Agriculture*, 12(9), 1500. <https://doi.org/10.3390/agriculture12091500>
- Shinde, R., Shahi, D. K., Mahapatra, P., Singh, C. S., Naik, S. K., Thombare, N., & Singh, A. K. (2022). Management of crop residues with special reference to the on-farm utilization methods: A review. *Industrial Crops and Products*, 181, 114772. <https://doi.org/10.1016/j.indcrop.2022.114772>
- Siedt, M., Schäffer, A., Smith, K. E. C., Nabel, M., Roß-Nickoll, M., & van Dongen, J. T. (2021). Comparing straw, compost, and biochar regarding their suitability as agricultural soil amendments to affect soil structure, nutrient leaching, microbial communities, and the fate of pesticides. *Science of The Total Environment*, 751, 141607. <https://doi.org/10.1016/j.scitotenv.2020.141607>
- Solaiman, Z. M., Yang, H., Archdeacon, D., Tippet, O., Tibi, M., & Whiteley, A. S. (2019). Humus-rich compost increases lettuce growth, nutrient uptake, mycorrhizal colonisation, and soil fertility. *Pedosphere*, 29(2), 170–179. [https://doi.org/10.1016/S1002-0160\(19\)60794-0](https://doi.org/10.1016/S1002-0160(19)60794-0)
- Stehouwer, R., Cooperband, L., Rynk, R., Biala, J., Bonhot, J., Antler, S., Lewandowski, T., & Nichols, H. (2022). Compost characteristics and quality. In *The Composting Handbook* (pp. 737–775). Elsevier. <https://doi.org/10.1016/B978-0-323-85602-7.00012-1>
- Urra, J., Alkorta, I., & Garbisu, C. (2019). Potential Benefits and Risks for Soil Health Derived From the Use of Organic Amendments in Agriculture. *Agronomy*, 9(9), 542. <https://doi.org/10.3390/agronomy9090542>
- van der Velden, R., da Fonseca-Zang, W., Zang, J., Clyde-Smith, D., Leandro, W. M., Parikh, P., Borrión, A., & Campos, L. C. (2022). Closed-loop organic waste management systems for family farmers in Brazil. *Environmental Technology*, 43(15), 2252–2269. <https://doi.org/10.1080/09593330.2021.1871660>
- Wai, C. W., Yan, W. H., Tsim, K. W. K., So, P. S., Xia, Y. T., & To, C. T. (2022). Effects of *Bacillus subtilis* and *Pseudomonas fluorescens* as the soil amendment. *Heliyon*, 8(11), e11674. <https://doi.org/10.1016/j.heliyon.2022.e11674>
- Wen, Z., Li, H., Shen, Q., Tang, X., Xiong, C., Li, H., Pang, J., Ryan, M. H., Lambers, H., & Shen, J. (2019). Tradeoffs among root morphology, exudation and mycorrhizal symbioses for phosphorus-acquisition strategies of 16 crop species. *New Phytologist*, 223(2), 882–895. <https://doi.org/10.1111/nph.15833>
- Yang, W., & Zhang, L. (2022). Addition of mature compost improves the composting of green waste. *Bioresource Technology*, 350, 126927. <https://doi.org/10.1016/j.biortech.2022.126927>

ЕВАЛУАЦИЈА НА КОМПСТИРАНА ЗЕЛКА (*Brassica oleracea* L.) КАКО СУПСТРАТ ЗА ОДГЛЕДУВАЊЕ РАСТЕНИЈА ВО ХОРТИКУЛТУРНОТО ПРОИЗВОДСТВО

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Резиме

Високите трошоци и ограничената достапност на конвенционалните супстрати за одгледување растенија во Замбија и супсахарска Африка претставуваат значителна пречка за одржливо градинарско производство. Ова истражување го оценува компостираниот отпад од зелка како економична и одржлива алтернатива за одгледување градинарски култури. Експериментите спроведени на Универзитетот Мулунгуши во Замбија го споредуваат компостираниот отпад од зелка со комерцијалниот супстрат Hugromix-Polirpor, користејќи зелка, краставица, домот и зелена пиперка како тест-култури. Компостираната зелка значително ја зголеми стапката на никнување кај зелката (94,44 %) и домотот (87,5 %), додека комерцијалниот супстрат беше поефикасен кај краставицата и зелената пиперка. Редоследот на никнување на културите беше поповолен кај компостираната зелка, при што прво никна зелката, потоа краставицата, домотот и зелената пиперка, што укажува на поволни услови за рано расадување. Компостираната зелка исто така ја подобри акумулацијата на биомаса, при што зелката покажа највисока акумулација на сува материја (51,39 %) во компостираниот супстрат, што укажува на негов потенцијал за поддршка на интензивен раст и висока продуктивност. Должината на коренот и виталноста на расадот покажаа слични трендови, при што компостираната зелка имаше позитивен ефект врз зелката и домотот. Анализата на трошоци и придобивки покажа корист-трошок сооднос од два (2) за компостираната зелка. Овие резултати покажуваат дека компостираната зелка претставува одржлива и економски исплатлива алтернатива на комерцијалните супстрати за одредени култури, придонесувајќи кон развојот на циркуларната биекономија преку рециклирање на земјоделски отпад. Понатамошните истражувања треба да бидат насочени кон усовршување на процесите на компостирање и испитување на пошироки можности за примена со цел зголемување на нејзината употребливост како универзален супстрат за растење.

Клучни зборови: биекономија, градинарство, воспоставување на расад, рециклирање на земјоделски отпад, економска исплатливост.