



Performance Evaluation of Pigeon Manure Tea Enriched with Agricultural Wastes-Derived Biostimulants as an Organic Nutrient Solution for Kratky Hydroponic Cultivation of Pechay (*Brassica Rapa Subsp. Chinensis*)

Anastasia A. San Diego ^a, Mirella L. Panis ^b, Cryssian Paula D. Santos ^c, Ivie Joy B. Badilla ^d, Jayson B. Eugelio, PhD ^e

^{a,b,c,d,e} San Miguel National High School, San Miguel, Bulacan, Philippines

DOI : <https://doi.org/10.55248/gengpi.07.0926.3106>

ABSTRACT:

Despite the advancements in technology, farming in the Philippines still heavily relies on chemical fertilizer to effectively supply the increasing demand for food production, which are expensive and could damage the environment if used frequently. Finding an alternative nutrient solution that is at low cost, eco-friendly, and locally available is a key step toward sustainable food production. This study aimed to examine the effectiveness of pigeon manure tea enhanced with agricultural waste as an organic nutrient solution for Kratky hydroponic cultivation of pechay (*Brassica rapa subsp. chinensis*). The efficacy of different fertilizer solutions was identified based on plant height, leaf count, leaf width, and also the physicochemical properties were determined through laboratory tests including pH, nitrogen, phosphorus, potassium, calcium, magnesium, and iron. For this experiment, four varying treatments were used: T1 (standard hydroponic nutrient solution), T2 (banana peels + pigeon manure), T3 (corn cobs + pigeon manure), and T4 (rice husk + pigeon manure). These fertilizers were fermented, tested in the laboratory, diluted, and applied to pechay grown using the Kratky hydroponic system. The data were assessed using Analysis of Variance (ANOVA). Results showed that T1 gave the best performance among all other treatments while T3 performed best among the organic treatments. The laboratory results showed that T4 had the highest nutrient content, indicating that other factors such as nutrient uptake and nutrient availability might have affected plant growth. These results show that the use of pigeon manure tea with agricultural waste as an organic nutrient solution for hydroponic pechay is possible. This finding is useful in relation to SDG 2 (Zero Hunger) and SDG 12 (Responsible Consumption and Production) by making use of agricultural waste as fertilizer material.

Keywords: Organic fertilizer, pigeon manure, agricultural waste, hydroponics, kratky method

1. Introduction

Agriculture plays an important role in providing food, promoting economic stability, and supporting the livelihoods of millions of Filipinos. Farming is one of the major subsectors of the economy, providing food and sustaining the lives of millions of people. As the population rises, the demand for food continues to rise, therefore, farmers are encouraged to heavily rely on synthetic fertilizers to support crop production and meet the growing demand for food. While these fertilizers are effective in improving crop yields, the excessive and long-term use of these fertilizers may contribute to environmental problems such as water pollution, eutrophication, soil degradation, and biodiversity loss (Ibañez et al., 2024). These concerns have encouraged the search for more sustainable and affordable alternatives to synthetic fertilizers.

Organic fertilizers are one possible alternative because they can provide nutrients while making use of available organic materials such as agricultural waste and manure. Plants require nutrients such as nitrogen, phosphorus, and potassium for proper growth, although their amount and availability vary depending on the organic materials used (Yosilia et al., 2023). Pigeon manure is a potential nutrient source because it contains the essential nutrients needed for crop growth such as nitrogen, phosphorus, and potassium and can be processed through fermentation and dilution to produce a liquid fertilizer (Duffaut et al., 2023; Muniappan et al., 2023). Agricultural wastes such as banana peels and corn cobs also contain nutrients and organic matter that may be useful as agricultural inputs and crop production (Aliyu et al., 2024; Budaistuti et al., 2023). Rice husk-derived organic materials have also shown potential for improving nutrient use in crop production (Ramli et al., 2023).

Hydroponic cultivation offers another way to grow vegetables by providing nutrients directly through water instead of soil. The Kratky method is a simple, non-circulating hydroponic system in which plants grow with their roots partially submerged in the nutrient solution. It does not require pumps or electricity, making it suitable for small-scale cultivation (Gumisiriza et al., 2022). Pechay (*Brassica rapa subsp. chinensis*) is suitable for this type of cultivation because of its relatively short growing period and nutritional value. Previous studies have also explored organic nutrient sources for hydroponic vegetable production, including pechay (Simeon & Bugawisan, 2023; Solis, 2023).

Although previous studies have examined organic fertilizers, animal manure, agricultural wastes, and hydroponic cultivation, limited research has focused on combining pigeon manure tea with banana peels, corn cobs, and rice husks as an organic nutrient solution for Kratky hydroponic cultivation of pechay. There is also limited information on the nutrient composition and effectiveness of these combinations in supporting plant growth. Therefore, this study focuses on the development and performance evaluation of pigeon manure tea enhanced with agricultural wastes as an organic nutrient solution for the Kratky hydroponic cultivation of pechay. It aims to determine their potential to support pechay growth while promoting agricultural waste utilization and reducing dependence on synthetic fertilizers.

Objective of the Study

This study aims to evaluate pigeon manure tea combined with different agricultural wastes such as banana peels, corn cobs, and rice husks as a fermented organic liquid fertilizer for the hydroponic growth of pechay (*Brassica rapa subsp. chinensis*). Specifically, it aims to determine the fertilizer's nutrient and chemical properties in terms of nitrogen, phosphorus, potassium, pH, calcium, magnesium, and iron; assess their effects on pechay growth based on plant height, leaf number, and leaf width; and determine whether significant differences exist among the organic fertilizer treatments and the standard hydroponic nutrient solution.

2. Methods

2.1 Collection of Raw Materials

Three (3) kilograms of pigeon manure were collected from local sources as the primary nutrient source in the organic fertilizer production, while one (1) kilogram of the desired agricultural wastes such as banana peels, corn cobs, and rice husks were gathered, following Carollo et al. (2023). 600 milliliters of molasses was also collected to serve as a support for microbial activity and a carbon source during fermentation, following Aftaoui et al. (2021). The materials were prepared according to ratio of one kilogram of pigeon manure, 1 kilogram of the desired agricultural waste, 10 liters of water, and 200 milliliters of molasses. The ratio was divided into two equal parts in case one of the mixtures became unusable. Therefore, each mixture has 500 grams of pigeon manure, 500 grams of the selected agricultural wastes, 5 liters of water, and 100 milliliters of molasses. A total of six (6) fermentation mixtures were prepared.

2.2 Anaerobic Fermentation and Filtration

The prepared mixtures were placed in closed containers to allow anaerobic fermentation and were stored in a shaded area to provide a suitable environment for microbial activity. The mixtures were fermented for approximately 21 days, following Priyadi et al. (2023), and were mixed every three (3) to five (5) days using clean wooden sticks to ensure the ingredients are evenly distributed. After fermentation, each mixture was filtered using a strainer and clean cloth to remove large and fine solid particles. The filtered liquid was transferred into clean plastic containers and allowed to settle at room temperature for two (2) days. After settling, the clearer liquid portion was carefully decanted to reduce suspended particles and excess odor before laboratory analysis and application.

2.3 Laboratory Chemical Analysis

One (1) liter of each fermented organic liquid fertilizer was submitted to the Bureau of Soils and Water Management (BSWM) in Diliman, Quezon City for physicochemical analysis. The samples were analyzed to determine their nutrient and chemical composition, including total nitrogen (N), phosphorus (P), potassium (K), iron (Fe), magnesium (Mg), calcium (Ca), and pH. The analysis was conducted to evaluate the nutrient characteristics and suitability of the fermented organic fertilizers as potential nutrient solutions for hydroponic pechay.

2.4 Organic Solution Dilution

Following laboratory analysis, the fermented organic liquid fertilizers were diluted before application to reduce the concentration of nutrients and prevent possible toxicity or root damage. For every 250 milliliters of fermented organic liquid fertilizer, 2 liters of water were added to produce the diluted organic nutrient solution, following the practices of Phibunwatthanawong and Riddech (2019). The same dilution procedure was applied consistently to the organic fertilizer treatments to maintain uniformity during the hydroponic experiment. The diluted solutions were then prepared for Kratky hydroponic systems.

2.5 Seedling Germination and Transplanting

Three (3) pechay seeds were initially sown in each moist horticultural foam and watered daily to maintain moisture and start germinating, following Solis (2023). After approximately three (3) days, when the seedlings began developing their first leaves, they were exposed to sunlight to promote healthy growth and was introduced to nutrient solution to prevent the crops becoming leggy. After fourteen (14) days, seedlings with approximately two (2) to three (3) true leaves and visible roots were selected for transplanting. The seedlings were carefully transferred into net cups containing

cocopeat as the growing medium, ensuring that the roots and stems were not damaged during transplantation. The prepared seedlings were then assigned to their respective nutrient solution treatments.

2.6 Kratky Hydroponic System

The Kratky hydroponic systems were prepared using eight (8) Styrofoam containers, with two (2) containers assigned to each fertilizer treatment to provide replicates for statistical analysis. Each container contained four (4) net cups, resulting in four pechay seedlings per container. The containers were cleaned and arranged under the same environmental conditions. The diluted nutrient solutions were added to the containers, and the net cups were positioned so that the lower portion of the growing medium and roots could access the nutrient solution while maintaining an air gap above the solution to provide oxygen for root development. The same setup and procedures were applied to all fertilizer treatments, including the control.

2.7 Growing Period

The transplanted pechay plants were grown under the same environmental conditions throughout the experimental period to minimize external factors that could affect plant growth. The plants were regularly monitored for plant height, leaf development, leaf width, overall appearance, nutrient solution level, and signs of nutrient deficiency or other growth problems. The nutrient solution levels were also checked regularly to ensure that the plants continued to have access to the solution while maintaining the necessary air space for the Kratky system. The growing period lasted approximately 30–45 days, until the plants reached maturity and were ready for harvesting. At the end of the growing period, the plants were harvested and assessed based on the selected growth parameters, following the practices of Solis (2023).

2.8 Data Analysis

The collected measurements for plant height, leaf width, and number of leaves were recorded, organized, and tabulated for each fertilizer treatment and replicate. The growth performance of pechay under the different organic fertilizer formulations was compared with the control treatment to determine differences in plant development. The data were statistically analyzed using a one-way Analysis of Variance (ANOVA) to determine whether significant differences existed among the fertilizer treatments. The results were then interpreted to evaluate the effectiveness of pigeon manure combined with different agricultural wastes as an organic nutrient solution for the hydroponic growth of pechay.

3. Results

3.1 Physicochemical Properties and Nutrient Composition of the Formulated Fertilizers

The laboratory results showed that the nutrient composition of the organic fertilizer formulations varied depending on what agricultural waste used. Rice Husk + Pigeon Manure recorded the highest nitrogen (1.31%), potassium (0.26%), calcium oxide (0.08%), magnesium oxide (0.05), pH (6.82), and iron (77.61 ppm), while Banana Peels + Pigeon Manure had the highest phosphorus (P_2O_5) at 0.10%. Nitrogen was not detected in the Corn Cobs + Pigeon Manure and Banana Peels + Pigeon Manure formulations, although both contained measurable phosphorus and potassium.

Table 1. Physicochemical Properties of the Formulated Organic Fertilizers

Tests Conducted	Corn Cobs + Pigeon Manure	Rice Husks + Pigeon Manure	Banana Peels + Pigeon Manure
Total Nitrogen (N)	ND	1.31%	ND
Total Phosphorus (P_2O_5)	0.09%	0.07%	0.10%
Total Potassium (K_2O)	0.18%	0.26%	0.25%
Total Calcium Oxide (CaO)	0.07%	0.08%	0.07%
Total Magnesium Oxide (MgO)	0.04	0.05	0.05
pH	5.66	6.82	6.03
Iron (Fe), ppm	55.87	77.61	59.94

Note: ND mean Not Detected

These nutrients may support plant growth, with nitrogen promoting leafy growth, phosphorus contributing to root development and nutrient transport, and potassium supporting water regulation and plant strength. The presence of calcium, magnesium, iron, and suitable pH levels also indicates potential to support plant development and nutrient uptake. These findings are consistent with Sharma et al. (2022) and Thomas et al. (2019), who reported that

nutrient composition varies according to what organic materials used. However, nutrient composition alone does not determine fertilizer effectiveness, which is further assessed through the growth performance of pechay.

3.2 Growth Performance of Pechay under Different Treatments

Table 2. Growth Parameters of Pechay

Treatment	Height (cm)	Leaf Width (cm)	Leaf Number
Control	21.9	6.8	8.9
Banana Peels + Pigeon Manure	19.6	5.8	8.75
Corn Cobs + Pigeon Manure	19.9	6.05	8.55
Rice Husks + Pigeon Manure	19.8	5.6	8.4

As presented in Table 2, the Control treatment consistently recorded the highest mean values for all growth parameters. Among the organic nutrient treatments, Corn Cobs + Pigeon Manure produced the highest mean plant height at 19.9 cm and the widest leaves at 6.05 cm, while Banana Peels + Pigeon Manure produced the highest mean leaf number among the organic treatments at 8.75 leaves per plant. Rice Husks + Pigeon Manure recorded the lowest leaf width and leaf number, with means of 5.6 cm and 8.4 leaves, respectively.

Overall, the Control treatment demonstrated the strongest numerical growth performance across all measured parameters. However, the organic treatments also supported the growth of pechay, although their mean values were generally lower than those of the Control treatment. The results suggest that the organic nutrient combinations may support plant development, but their effectiveness differed according to the growth parameter measured.

3.3 Significant Differences Among Treatments

Table 3. One-Way ANOVA among the Parameters

Parameter	F-value	p-value	Interpretation
Plant Height	2.3331	0.09554	Not Significant
Leaf Width	6.5945	0.00164	Significant
Number of Leaves	0.04449	0.9873	Not Significant

ANOVA showed no significant difference in plant height with the F-value of 2.3331 and a p-value of 0.09554, as well as the number of leaves at the F-value of 0.04449 and a p-value of 0.9873 among the four treatments. Although the control had the highest numerical means for these parameters, the differences were not statistically significant. In contrast, leaf width showed a significant difference with a F-value of 6.5945 and a p-value of 0.00164, indicating that the fertilizer treatments affected leaf expansion. The control had the widest leaves, while rice husks + pigeon manure had the narrowest.

The significant difference in leaf width is consistent with Simeon and Bugawisan (2023), who emphasized the role of nutrient availability in leaf development. The lack of significant differences in leaf number also agrees with Ibañez et al. (2024), who reported limited differences in leaf production among nutrient sources. Overall, the statistical results show that treatment effects varied depending on the growth parameter measured.

4. Conclusion

This study demonstrated that Corn Cobs + Pigeon Manure Fermented Organic Liquid Fertilizer can serve as an alternative nutrient solution for the growth of pechay (*Brassica rapa subsp. chinensis*) due to its sufficient nutrient composition to support plant growth. The findings indicate that the type of organic material can influence the nutrient composition of an organic fertilizer. Among the treatments, the Inorganic Fertilizer solution applied to hydroponics pechay achieved the highest plant height, leaf width, and number of leaves, while the Corn Cobs + Pigeon Manure solution produced equivalent outcomes, showing its potential as a sustainable substitute. In contrast, the results also showed that the Banana Peels + Pigeon Manure fermented organic fertilizer treatment resulted in significantly lower leaf width growth, suggesting that nutrient concentration plays a critical role in maximizing the effectiveness of organic solutions. Overall, Corn Cobs + Pigeon Manure fermented liquid organic fertilizer solution proved to be a promising eco-friendly alternative nutrient solution for the hydroponic growth of pechay, though further studies are recommended to match the efficiency of conventional nutrient solutions.

5. Recommendations

Future studies should look into availability, release and uptake to understand why the formulation with the highest laboratory nutrient values did not lead to the best plant growth performance. Researchers should extend the growing period. Include measurements such as fresh weight, total biomass, root length and yield. Larger sample sizes and more replications should be used to improve the accuracy and reliability of the data. The developed formulations should also be tested on hydroponically grown leafy vegetables to see how effective they are across different crop species. Different ratios of pigeon manure, agricultural wastes, water and molasses should be evaluated to find formulations, with balanced nutrient compositions. Finally, experiments should be conducted in a greenhouse or another controlled environment to reduce the impact of pest infestations and environmental variation supporting more consistent plant development.

Acknowledgements

The researchers gratefully acknowledge San Miguel National High School for providing the facilities and laboratory assistance used in the preparation and analysis of the fertilizer formulations. Sincere thanks are extended to the project adviser, Ivie Joy B. Badilla, for her invaluable guidance and support throughout the conduct of the study, as well as for her advice, suggestions, and feedback that helped the researchers improve the study and complete its different stages. The researchers also express their heartfelt appreciation to Sir Jose Paulo De Jesus for his assistance in providing the pigeon manure materials needed for the preparation of the fertilizer formulations and for his support during the conduct of the study. The team further extend their sincere gratitude to Sir Jayson Eugelio for his guidance, encouragement, and assistance throughout the research process. His reminders, suggestions, and support as a teacher helped the researchers stay organized, focused, and attentive to the requirements and responsibilities involved in completing the study. The project team also thank all individuals who provided assistance, cooperation, and encouragement throughout the preparation, experimentation, data gathering, and completion of this research.

References

- Aliyu, M., Abdulmalik, Z., Bako, Z. M., Jega, R. M., & Kareem, W. (2024). Organic fertilizer production using banana peel, eggshells, and yeast: Effects on *Amaranthus* growth. *FUDMA Journal of Sciences*, 8(6), 562–567. <https://doi.org/10.33003/fjs-2024-0806-3022>
- Budiastuti, M. T. S., Purnomo, D., Pujiasanto, B., & Setyaningrum, D. (2023). Response of maize yield and nutrient uptake to indigenous organic fertilizer from corn cobs. *Agriculture*, 13(2), 309. <https://doi.org/10.3390/agriculture13020309>
- Duffaut, C., Brondeau, F., & Gasparini, J. (2023). An original and efficient fertilizer for cherry tomato plants grown in urban agriculture: Feral pigeon guano. *Urban Agriculture & Regional Food Systems*, 8(1), e20046. <https://doi.org/10.1002/uar2.20046>
- Gumisiriza, M. S., Ndakidemi, P. A., & Mbega, E. R. (2022). A simplified non-greenhouse hydroponic system for small-scale soilless urban vegetable farming. *MethodsX*, 9, 101882. <https://doi.org/10.1016/j.mex.2022.101882>
- Ibañez, R. Y., Balansag, G. C., & Puod, N. G. D. (2024). Effects of different manures on the growth performance of pechay (*Brassica rapa* L.) under Visayas State University condition. *ASEAN Journal of Scientific and Technological Reports*, 28(1), e255634. <https://doi.org/10.55164/ajstr.v28i1.255634>
- Muniappan, V., Hepsibha, B. T., & Jayanthi, P. (2023). Fermented liquid biofertilizer from banana waste—A value added product. *Innovations in Agriculture*, 6, 1–5. <https://doi.org/10.25081/ia.2023-07>
- Ramli, N. H., Badrul Hisham, N. E., & Baharulrazi, N. (2023). The effectiveness of rice husk ash as additive in palm oil-based compost in enhancing the nitrogen uptake by *Brassica oleracea* var. *alboglabra* L. (Chinese kale) plant. *Pertanika Journal of Tropical Agricultural Science*, 46(1), 315–328. <https://doi.org/10.47836/pjtas.46.1.17>
- Simeon, L. B., & Bugawisan, E. P. (2023). Potential of vermitea and nutrient solution under non-circulating hydroponic system on production performance of pechay (*Brassica rapa* L.). *EPRA International Journal of Agriculture and Rural Economic Research*, 11(5), 40–51. <https://doi.org/10.36713/epra0813>
- Solis, E. S. (2023). Performance evaluation of pechay (*Brassica rapa* var. *chinensis*) using different organic growing media under hydroponic system. *IOP Conference Series: Earth and Environmental Science*, 1208(1), 012038. <https://doi.org/10.1088/1755-1315/1208/1/012038>
- Yosilia, R., Hoya, A. L., Erlangga, M. F., Kamelia, M., & Alkausar, T. (2023). NPK concentration in liquid maggot fertilizer made from different organic resources analyzed. *Al Ulum: Jurnal Sains dan Teknologi*, 9(3), 96. <https://doi.org/10.31602/jst.v9i3.11922>
- Atfaoui, K., Ettouil, A., Fadil, M., Asmaa, O., Inekach, S., Ouhssine, M., & Zarrouk, A. (2021). Controlled fermentation of food industrial wastes to develop a bioorganic fertilizer by using experimental design methodology. *Journal of the Saudi Society of Agricultural Sciences*, 20(8), 544–552. <https://doi.org/10.1016/j.jssas.2021.06.003>

-
- Carollo, F. S., Lampa, M. A., & Frias, J. C. P. (2023). Granular bioorganic chicken manure and banana peel (*Musa paradisiaca*): An alternative to complete fertilizer (14-14-14) for rice production. *International Journal of Agriculture and Animal Production*, 3(2), 1–10. <https://doi.org/10.55529/ijaap.34.1.11>
 - Priyadi, D. A., Toni, S., & Istanti, A. (2023). Utilization of different concentration sugarcane molasses to the quality of goat feces-chicken excreta-coconut husk organic liquid fertilizer. *Buletin Peternakan*, 47(1), 36–43. <https://doi.org/10.21059/buletinpeternak.v47i1.80378>
 - Phibunwatthanawong, T., & Riddech, N. (2019). Liquid organic fertilizer production for growing vegetables under hydroponic condition. *International Journal of Recycling of Organic Waste in Agriculture*, 8(4), 369–380. <https://doi.org/10.1007/s40093-019-0257-7>
 - Sharma, R., Kandel, S., Khadka, S., & Chaudhary, S. (2022). Nutrient contents in different sources of organic manures used in different farms of Bhaktapur district, Nepal. *Journal of Agriculture and Natural Resources*, 5(1), 150–156. <https://doi.org/10.3126/janr.v5i1.50705>
 - Thomas, C. L., Acquah, G. E., Whitmore, A. P., McGrath, S. P., & Haeefe, S. M. (2019). The effect of different organic fertilizers on yield and soil and crop nutrient concentrations. *Agronomy*, 9(12), 776. <https://doi.org/10.3390/agronomy9120776>