COMPARATIVE ANALYSIS OF THE EFFICACY OF *Trichoderma harzianum* USING TWO DIFFERENT SUBSTRATES FOR THE PRODUCTION OF BUFFALO-MANURE-BASED COMPOST AS A SUSTAINABLE MANURE WASTE MANAGEMENT SYSTEM

RAMONCITA P. VALDEZ

An Undergraduate Thesis Submitted to the Faculty of the Department of Environmental Science, College of Science, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines
in Partial Fulfillment of the Requirements
for the Degree of

BACHELOR OF SCIENCE IN ENVIRONMENTAL SCIENCE
(Environmental Conservation and Management)

JULY 2023

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF APPENDIX TABLES

LIST OF APPENDIX FIGURES

ABSTRACT

VALDEZ, RAMONCITA P., Department of Environmental Science, College of Science, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines, **July 2023**, **COMPARATIVE ANALYSIS OF THE EFFICACY OF *Trichoderma harzianum* USING TWO DIFFERENT SUBSTRATES FOR THE PRODUCTION OF BUFFALO-MANURE-BASED COMPOST AS A SUSTAINABLE MANURE WASTE MANAGEMENT SYSTEM**

Adviser: SHARON E. LAZARO, Ph.D.
Co-Adviser: ESTELLA P. VALIENTE, M.Sc.

Rapid composting is an essential process for organic manure waste management and the production of nutrient-rich soil amendments or organic fertilizer. This study aimed to investigate the efficacy of *T. harzianum* in composting by evaluating the time of full decomposition and comparative analysis of the physical qualitative analysis and physiochemical properties. The Institute of Biological Sciences (IBS) small scale rapid composting is used for the experimental set up. Results revealed that *T. harzianum* significantly accelerated the decomposition of organic matter mixture substrates compared to the control groups. The process consists of two steps: the use of a compost fungus activator or the T. harzianum as bioinoculants for active decomposer and the composting process itself. In the two substrates, 12 kg of pure buffalo manure and 2:1:1 ratio of manure, rice straw and CRH for organic matter mixture substrates. The combined mixture of 1.14 liters of distilled water with 14.4 grams of T. harzianum bioinoculant was equally applied and sprayed with 190 ml for each compost block in treatment 3 and 4. The composts post analysis comparison, PBM substrates shows significant results in a positively increase amount of N, P, K. The OMM substrates, moisture content and phosphorus are significantly difference. The pH level of all the treatments meets the standard of 5.5 to 8. The presence

of *T. harzianum* in the organic matter mixture compost also led to accelerated decomposition compared to the PBM substrates and the two control treatments. The days of full decomposition achieved in a shorter time period for about 53 days in treatment 4 (OMM with TZ) compared to the control group.

Keywords: *T. harzianum;* pure buffalo manure; rapid composting; rice straw

LITERATURE CITED

Adhikary, S. (2012). Vermicompost, the story of organic gold: A review. Agricultural Sciences, 03(07), 905–917. https://doi.org/10.4236/as.2012.37110

Adugna, G. (2016). A review on impact of compost on soil properties, water use and crop productivity. Academic Research Journal of Agricultural Science and Research, 4(3), 93-104.

Ahmed, S., Bashir, A., Saleem, H., Saadia, M., & Jamil, A. (2009). Production and purification of cellulose-degrading enzymes from a filamentous fungus T. harzianum. Pak J Bot, 41(3), 1411-1419

Angraeni, L., Sriwati, R., & Susanna. (2020). Application of Various Species of Trichoderma spp. in Composting Cocoa Pod Husk Contaminated Phytophthora palmivora. IOP Conference Series: Earth and Environmental Science, 515(1), 012069. https://doi.org/10.1088/1755-1315/515/1/012069

Ayilara, M. S., Olanrewaju, O.S., Babalola, O.O., and Odeyemi, O. (2020). Waste management through composting: Challenges and potentials Sustain.

Bao, Y.; Feng, Y., Qiu, C., Zhang, J., Wang, Y., Lin, X. (2021). Organic matter- and temperature-driven deterministic assembly processes govern bacterial community composition and functionality during manure composting. https://europepmc.org/article/med/34091236

Bera, R., Bose, S., Dey, G. C., & Sarkar, R. K. (2013). Comparative Evaluation of Compost Quality, Process Convenience and Cost under Different Composting Methods to assess their Large-Scale Adoptability Potential as also Complemented by Compost Quality Index.

Bernal, M., Alburquerque, J., & Moral, R. (2009). Composting of animal manures and chemical criteria for compost maturity assessment. A review. Bioresource Technology, 100 (22), 5444-5453. https://doi.org/10.1016/j.biortech.2008.11.027

Blaya, J., López-Mondéjar, R., Lloret, E., Pascual, J. A., & Ros, M. (2013). Changes induced by *T. harzianum* in suppressive compost controlling Fusarium wilt. Pesticide Biochemistry and Physiology, 107(1), 112–119. https://doi.org/10.1016/j.pestbp.2013.06.001

Borghese, A. (2005). Buffalo production and research. REU Technical Series, 67

Burton, C. H., and Turner, C. (2003). Manure Management Treatment and Strategies for Sustainable Agriculture 2nd ed. Silsoe Research Institute

Calub, A.D., Saludes, R.B., and Tabing, E.V.P. (2016). "An Overview of Agricultural Pollution in the Philippines: The Livestock Sector." Prepared for the World Bank, Washington, D.C

Chadwick, D., Cardenas, L., Dhanoa, M., Donovan, N., Misselbrook, T., Williams, J., Thorman, R., McGeough, K., & Watson, C., Bell, M., Anthony, S., & Rees, R. (2018). The contribution of cattle urine and dung to nitrous oxide emissions: Quantification of country-specific emission factors and implications for national inventories. Science of the Total Environment, 635, 607–617. https://doi.org/10.1016/j.scitotenv.2018.04.152

Chen, L., de Haro Marti, M., Moore, A., & Falen, C. (2011). The composting process. Dairy Manure Compost Production and Use in Idaho, 2, 513-532.

Chen, X., Liu, R., Hao, J., Li, D., Wei, Z., Teng, R., & Sun, B. (2019). Protein and carbohydrate drive microbial responses in diverse ways during different animal manures composting. Bioresource Technology, 271, 482–486. https://doi.org/10.1016/j.biortech.2018.09.096

Chivenge, P., Rubianes, F., Chin, D. V., Thach, T. V., Khang, V. T., Romasanta, R. R., ... & Trinh, M. V. (2020). Rice straw incorporation influences nutrient cycling and soil organic matter. In *Sustainable rice straw management* (pp. 131-144). Springer, Cham.

Cracas, P. (2000). Vermicomposting Cuban style.Vermicomposting Cuban Style.

Cuevas, V. C. (1997). Rapid composting technology in the Philippines: Its role in producing good-quality organic fertilizers. Food & Fertilizer Technology Center

Cuevas, V. C., Samulde, S. N., & Pajaro, P. G. (1988). *T. harzianum* Rifai as activator for rapid composting of agricultural wastes. *Philipp Agric*, *71*(4), 461-469

Doni, F., Isahak, A., Che Mohd Zain, C. R., Mohd Ariffin, S., Wan Mohamad, W. N. A., & Wan Yusoff, W. M. (2014). Formulation of Trichoderma sp. SL2 inoculants using different carriers for soil treatment in rice seedling growth. *Springerplus*, *3*, 1-5.

Druzhinina, I. S., Seidl-Seiboth, V., Herrera-Estrella, A., Horwitz, B. A., Kenerley, C. M., Monte, E., ... & Kubicek, C. P. (2011). Trichoderma: the genomics of opportunistic success. Nature reviews microbiology, 9(10), 749-759

Errington, J., & Aart, L. T. V. D. (2020). Microbe Profile: Bacillus subtilis: model organism for cellular development, and industrial workhorse. Microbiology, 166(5), 425–427. https://doi.org/10.1099/mic.0.000922

Fernandes, L., & Sartaj, M. (2013). Comparative Study of Static Pile Composting Using Natural, Forced and Passive Aeration Methods.

G. A., M., S. A., B., & S. G., O. (2013). Effects of Dietary Crude Protein on Performance and Nitrogen Economy of Broilers. Sustainable Agriculture Research, 2(3), 52. https://doi.org/10.5539/sar.v2n3p52

Gadde, B., Bonnet, S., Menke, C., & Garivait, S. (2009). Air pollutant emissions from rice straw open field burning in India, Thailand and the Philippines. *Environmental Pollution*, *157*(5), 1554-1558.

Gandhi, M., Sangwan, V., Kapoor, K.K. and Dilbaghi, N. (1997) Composting of household wastes with and without earthworms. Environment and Ecology, 15, 432–434

Geisel, P. M., & Unruh, C. L. (2007). Compost in a Hurry. https://doi.org/10.3733/ucanr.8037

Gerber, P., Chilonda, P., Franceschini, G., & Menzi, H. (2005). Geographical determinants and environmental implications of livestock production intensification in Asia. Bioresource Technology, 96(2), 263–276. https://doi.org/10.1016/j.biortech.2004.05.016

Ghorbani, F., Karimi, M., Biria, D., Kariminia, H. R., & Jeihanipour, A. (2015). Enhancement of fungal delignification of rice straw by Trichoderma viride sp. to improve its saccharification. *Biochemical Engineering Journal*, *101*, 77-84

Gou, C., Wang, Y., Zhang, X., Lou, Y., & Gao, Y. (2017). Inoculation with a psychrotrophic-thermophilic complex microbial agent accelerates onset and promotes maturity of dairy manure-rice straw composting under cold climate conditions. Bioresource Technology, 243, 339–346. https://doi.org/10.1016/j.biortech.2017.06.097

Gupta, V., & Sharma, A. K. (2013). Assessment of optimum temperature of *T. harzianum* by monitoring radial growth and population dynamics in different compost manures under different temperature. Octa journal of biosciences, 1(2).

Haddadin, M. S., Haddadin, J., Arabiyat, O. I., & Hattar, B. (2009). Biological conversion of olive pomace into compost by using *T. harzianum* and Phanerochaete chrysosporium. Bioresource technology, 100(20), 4773-4782.

Hall, M. B. (2002). Characteristics of manure: what do they mean. In Proc. Tri-State Dairy Nutrition Conference, April (pp. 16-17)

Heidarzadeh, M. H., Amani, H., & Javadian, B. (2019). Improving municipal solid waste compost process by cycle time reduction through inoculation of Aspergillus niger. Journal of Environmental Health Science and Engineering, 17(1), 295–303. https://doi.org/10.1007/s40201-019-00348-z

Inckel, M., De Smet, P., Tersmette, T., & Veldkamp, T. (2005). The preparation and use of compost. The Preparation and Use of Compost.

Infascelli, R., Faugno, S., Pindozzi, S., Pelorosso, R., & Boccia, L. (2010). The environmental impact of buffalo manure in areas specialized in mozzarella production, southern Italy. Geospatial Health, 5(1), 131. https://doi.org/10.4081/gh.2010.193

Irshad, M., Eneji, A. E., Hussain, Z., & Ashraf, M. (2013). Chemical characterization of fresh and composted livestock manures. Journal of soil science and plant nutrition, 13(1), 115-121

Joos, L., Herren, G. L., Couvreur, M., Binnemans, I., Oni, F. E., Höfte, M., Debode, J., Bert, W., & Steel, H. (2020). Compost is a carrier medium for Trichoderma harzianum. Biocontrol, 65(6), 737–749. https://doi.org/10.1007/s10526-020-10040-z

Júnior, L. F., Andrade, E. C. C., Pereira, N., Tokura, L. K., Secco, D., & Carvalho-Zanão, M. P. (2022). Contribution of the carbonized rice husk added to the substrate in the production of vegetable seedlings. Bioscience Journal, 38, e38029. https://doi.org/10.14393/bj-v38n0a2022-54050

Khater, E. G. (2015). Some Physical and Chemical Properties of Compost. International Journal of Waste Resources, 05(01). https://doi.org/10.4172/2252-5211.1000172

Kiruba N, J. M., & Saeid, A. (2022). An Insight into Microbial Inoculants for Bioconversion of Waste Biomass into Sustainable "Bio-Organic" Fertilizers: A Bibliometric Analysis and Systematic Literature Review. International Journal of Molecular Sciences, 23(21), 13049. https://doi.org/10.3390/ijms232113049

Koelsch, R., and Wiederholt, R., (2022). Livestock and Poultry Environmental Learning Community Environmental Benefits of Manure Application

Kumar, R. R., Park, B. J., & Cho, J. Y. (2013). Application and environmental risks of livestock manure. Journal of the Korean Society for Applied Biological Chemistry, 56(5), 497–503. https://doi.org/10.1007/s13765-013-3184-8

Kumar, S., Negi, S., Mandpe, A., Singh, R. V., & Hussain, A. (2018). Rapid composting techniques in Indian context and utilization of black soldier fly for enhanced decomposition of biodegradable wastes - A comprehensive review. Journal of Environmental Management, 227, 189–199. https://doi.org/10.1016/j.jenvman.2018.08.096

Ladha, J. K., Khind, C. S., Khera, T. S., & Bueno, C. S. (2004). Effects of residue decomposition on productivity and soil fertility in rice–wheat rotation. *Soil Science Society of America Journal*, *68*(3), 854-864.

Leconte, M., Mazzarino, M. J., Satti, P., Iglesias, M., & Laos, F. (2009). Co-composting rice hulls and/or sawdust with poultry manure in NE Argentina. Waste Management, 29(9), 2446–2453. https://doi.org/10.1016/j.wasman.2009.04.006

Lee, S. J., Jang, Y. S., Lee, Y. M., Lee, J. J., Lee, H. B., Kim, G. H., & Kim, J. J. (2011). Rice straw-decomposing fungi and their cellulolytic and xylanolytic enzymes. *Journal of microbiology and biotechnology*, *21*(12), 1322-1329

Lopez, L. L. M. A., Aganon, C. P., & Juico, P. P. (2014). Isolation Of Trichoderma Species from Carabao Manure And Evaluation Of Its Beneficial Uses. International Journal of Scientific & Technology Research, 3(8), 190–199.https://www.ijstr.org/final-print/aug2014/Isolation-Of-Trichoderma Species-From-Carabao-Manure-And-Evaluation-Of-Its-Beneficial-Uses.pdf

Lu, J., Wang, J., Gao, Q., Li, D., Chen, Z., Wei, Z., Zhang, Y., & Wang, F. (2021). Effect of Microbial Inoculation on Carbon Preservation during Goat Manure Aerobic Composting. Molecules, 26(15), 4441. https://doi.org/10.3390/molecules26154441

Mahr, S. (2014). Using Manure in the Home Garden. University of Wisconsin – Madison

Malomo, G. A., Madugu, A. S., & Bolu, S. A. (2018). Sustainable Animal Manure Management Strategies and Practices. Agricultural Waste and Residues. https://doi.org/10.5772/intechopen.78645

Mikanová, O., Ust'ak, S., & Czakó, A. (2009). Utilization of microbial inoculation and compost for revitalization of soils. Soil and Water Research, 4(No. 3), 126–130. https://doi.org/10.17221/9/2009-swr

Misra, R. V., Roy, R. N., & Hiraoka, H. (2003). On-farm composting methods. Rome, Italy: UN-FAO

Mohamed Raimi, H.S., Tuan Ismail, T.N.H., Mohamed Najib, M.Z. and Mohamed Yusop, F. (2020). Food waste solution at home: conventional and rapid composting techniques

Munroe, G. (2007). Manual of on-farm vermicomposting and vermiculture. Organic Agriculture Centre of Canada, 39, 40.

Naeem, U., Haq, I. U., Afzaal, M., Qazi, A., Yasar, A., Tabinda, A. B., Mahfooz, Y., Naz, A. U., & Awan, H. (2021). Investigating the effect of Aspergillus niger inoculated press mud (biofertilizer) on the potential of enhancing maize (Zea mays. L) yield, potassium use efficiency and potassium agronomic efficiency. Cereal Research Communications, 50(1), 157–170. https://doi.org/10.1007/s42976-021-00153-1

Nagavallemma, K.P., Wani, S.P., Stephane, L., Padmaja, V.V., Vineela, C., Babu Rao, M. and Sahrawat, K.L. (2004). Vermicomposting: Recycling wastes into valuable organic fertilizer. Global Theme on Agroecosystems Report No. 8. Patancheru 502 324

Oenema, O. (2006). Nitrogen budgets and losses in livestock systems International Congress Series.

Organo, N. D., Granada, S. M. J. M., Pineda, H. G. S., Sandro, J. M., Nguyen, V. H., & Gummert, M. (2022). Assessing the potential of a Trichoderma-based compost activator to hasten the decomposition of incorporated rice straw. Scientific Reports, 12(1). https://doi.org/10.1038/s41598-021-03828-1

Pan, M., Gan, X., Mei, C., & Liang, Y. (2017). Structural analysis and transformation of biosilica during lignocellulose fractionation of rice straw. *Journal of Molecular Structure, 1127*, 575-582

Parastesh, F., Alikhani, H. A., & Etesami, H. (2019). Vermicompost enriched with phosphate–solubilizing bacteria provides plant with enough phosphorus in a sequential cropping under calcareous soil conditions. Journal of Cleaner Production, 221, 27–37. https://doi.org/10.1016/j.jclepro.2019.02.234

Pellejero, G., Ardizzi, C., Aschkar, G., Chorolque, A., & Ballesta, R. (2015). Quality Assessment by Aspergillus niger of an Onion, Cattle Manure and Alfalfa Waste Compost Blend. International Journal of Plant &Amp; Soil Science, 8(2), 1–8. https://doi.org/10.9734/ijpss/2015/18469

Philippine National Standard (PNS) Bureau of Agriculture and Fisheries Standards (BAFS) (2000) Organic Soil Amendments

Pratiwi, V., Hifnalisa, Oktarina, R., Sriwat, R. (2021). The potential of Trichoderma spp. and Pseudomonas auregenosa as patchouli waste decomposer

Raj Singh Choudhary, R.S., and Yadav, N.K. (2021). Biofertilizers (Microbial Inoculants

Rani, M.P., Prince William, S.P.M., Bhattacharyya, J.K., Chakrabarti, T., Devotta, S., (2007). Microbial dynamics and enzyme activities during rapic composting of municipal solid waste – A compost maturity analysis perspective

Restitrisnani,V., Sholihah, L.M., Mukminah, N., Ryanuari, R. G., Luthfi, N., Prawoto, A.A., Rianto, E., and Purnomoadi, A. (2019). Buffalo is more environmentally friendly than cattle based on N excretion

Romasanta, R. R., Sander, B. O., Gaihre, Y. K., Alberto, M. C., Gummert, M., Quilty, J., ... & Wassmann, R. (2017). How does burning of rice straw affect CH4 and N2O emissions? A comparative experiment of different on-field straw management practices. Agriculture, ecosystems & environment, 239, 143-153

Sahito, A. R., Mahar, R. B., & Brohi, K. M. (2013). Anaerobic biodegradability and methane potential of crop residue co-digested with buffalo dung. Mehran University Research Journal of Engineering & Technology, 32(3), 509-515

Sayeesh, P. K. (2015). *Cu-Chi-Tri: A triple combination for the management of late blight disease of potato (Solanum tuberosum L.)* (Doctoral dissertation, GB Pant University of Agriculture and Technology)

Sander, B. O., Quilty, J., Balingbing, C., Castalone, A. G., Romasanta, R., Alberto, M. C. R., ... & Gummert, M. (2019). An assessment of irrigated rice production energy efficiency and environmental footprint with in-field and off-field rice straw management practices. Scientific Reports, 9(1), 1-12

Schroth, G. (2002). Decomposition and nutrient supply from biomass. Trees, Crops and Soil Fertility: Concepts and Research Methods, 131–150. https://doi.org/10.1079/9780851995939.0131

Schroth, G., & Sinclair, F. L. (Eds.). (2002). Trees, crops and soil fertility: concepts and research methods. Trees, Crops and Soil Fertility: Concepts and Research Methods. https://doi.org/10.1079/9780851995939.0000

Shukla, N., Awasthi, R. P., Rawat, L., & Kumar, J. (2012). Biochemical and physiological responses of rice (Oryza sativa L.) as influenced by *T. harzianum* under drought stress. *Plant Physiology and Biochemistry*, *54*, 78-88.

Sood, M., Kapoor, D., Kumar, V., Sheteiwy, M. S., Ramakrishnan, M., Landi, M., ... & Sharma, A. (2020). Trichoderma: The "secrets" of a multitalented biocontrol agent. *Plants*, *9*(6), 762.

Stehouwer, R., Cooperband, L., Rynk, R., Biala, J., Bonhotal, J., Antler, S., ... & Nichols, H. (2022). Compost characteristics and quality. In The Composting Handbook (pp. 737-775). Academic Press.

Suyal, D. C., Soni, R., Sai, S., & Goel, R. (2016). Microbial Inoculants as Biofertilizer. Microbial Inoculants in Sustainable Agricultural Productivity, 311–318. https://doi.org/10.1007/978-81-322-2647-5_18

Van Der Meer, H., Sommer, S. G., Smith, K., Matsunaka, T., & Ong, H. K. (2008). Guidelines for sustainable manure management in Asian livestock production systems. IAEA-TECDOC-1582, 1–118.

Wan, L., Wang, X., Cong, C., Li, J., Xu, Y., Li, X., Hou, F., Wu, Y., & Wang, L. (2020). Effect of inoculating microorganisms in chicken manure composting with maize straw. Bioresource Technology, 301, 122730. https://doi.org/10.1016/j.biortech.2019.122730

Wu, W., Wang, Z., Jin, Y., Matsumoto, Y., & Zhai, H. (2014). Effects of LiCl/DMSO dissolution and enzymatic hydrolysis on the chemical composition and lignin structure of rice straw. *biomass and bioenergy*, *71*, 357-362

Yamamoto, N., Otawa, K., & Nakai, Y. (2010). Diversity and abundance of ammonia-oxidizing bacteria and ammonia-oxidizing archaea during cattle manure composting. Microbial Ecology, 60, 807-815

Zhou, C., Liu, Z., Huang, Z. L., Dong, M., Yu, X. L., & Ning, P. (2015). A new strategy for co-composting dairy manure with rice straw: Addition of different inocula at three stages of composting. Waste Management, 40, 38–43. https://doi.org/10.1016/j.wasman.2015.03.016

Zin, N. S. M., & Badaluddin, N. A. (2020). Biological functions of Trichoderma spp. for agriculture applications. Annals of Agricultural Sciences, 65(2), 168–178. https://doi.org/10.1016/j.aoas.2020.09.003