

**QUALITY OF ORGANIC FERTILIZER FROM BIOGAS-DIGESTER
SPENT SWINE SLUDGE**

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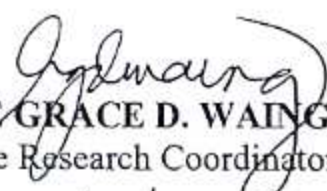
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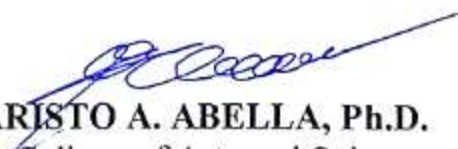
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BIOGRAPHICAL SKETCH

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ABSTRACT

DELA CRUZ, CYRILL SHAME N., Department of Environmental Science, College of Arts and Sciences, Central Luzon State University, Science City of Munoz, Nueva Ecija, Philippines, February 2020, **QUALITY OF ORGANIC FERTILIZER FROM BIOGAS-DIGESTER SPENT SWINE SLUDGE**

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Tons of organic waste such as swine manure are being generated and represents a major contributing factor to eutrophication and pollution of water bodies in the country. To reduce the risk of pollution and greenhouse gas emissions, swine manure can be used to produce biogas, a renewable source of energy using biogas-digester waste-management strategy that generates and capture methane gas. Results showed that T1 (sludge+CRH) obtained the highest NPK content of 3.25% followed by T4 (sludge+DL+RS+CRH) with 2.31% then T3 (sludge+RS+CRH) with 2.13% and T2 (sludge+DL+ CRH) with the lowest NPK content of 1.88%. Temperature, odor, pH and percent recovery were also determined and evaluated in each treatment. Therefore, In this study, the biogas-digester spent sludge from a swine farm when combined with different substrates resulted to production of soil conditioner.

Keywords: organic fertilizer; biogas production; swine sludge; agricultural wastes

LITERATURE CITED

- Ameen, A., Ahmad, J. & Raza, S. (2016). Effect of pH and moisture content on composting of municipal solid waste. *International Journal of Scientific and Research Publications*, 6(5), 35-36.
- Atienza, V. (2011). Review of the waste management system in the Philippines: Initiatives to promote waste segregation and recycling through good governance. In M. Kojima & E. Michida (Ed.), *In Economic Integration and Recycling in Asia: An Interim Report*, 65-68. Tokyo: Chosakenkyu Hokokusho.
- Chan, M. T. (2015). *Optimizing food waste composting process in fed-batch composter*, Unpublished master's thesis, Hongkong Baptist University, Kowloon Tong, Hong Kong.
- Cooperband, L. (2000). Composting: Art and science of organic waste conversion to a valuable soil resource. *Laboratory Medicine*, 31(5), 283-290. doi.org/10.1309/W286-LQF1-R2M2-1WNT
- Duong, T. T. T. (2013). *Compost effects on soil properties and plant growth*, Unpublished doctoral dissertation, University of Adelaide, Australia.
- Eusufzai, M. K., Tokida, T., Sugiyama, S., Nakajima, M. & Sameshima, R. (2011). Effect of rice straw application on CH₄ emission in continuous and recently converted paddy fields. *Journal of Agricultural Meteorology*, 67(3), 185-192. doi.org/10.2480/agrmet.67.3.2
- Evuti, A. M., & Lawal, M. (2015). Recovery of coagulants from water works sludge: A review. *Advances in Applied Science Research*, 2(6), 410-417.
- Gabbay, O. (2010). Assessment of the avenor pilot community composting facility and its adaptability in other accra sub-metro areas. *CHF International Ghana*. Columbia University: New York, NY.
- Galindez, J. L., Porciuncula, F. L., Lopez, L. L. M. A., Pascua, M. P., Romero, E. S., & Juico, P. P. (2017). Efficiency of *Trichoderma spp.* from carabao manure as compost activator and utilization of organic fertilizer produced in pechay and lettuce production. *International Journal of Agricultural Technology*, 13(5), 683-697.
- Garg, N. K. (2010). *Multicriteria assessment of alternative sludge disposal methods*, Unpublished master's thesis, University of Strathclyde, Glasgow, Scotland.
- Gautam, S. P., Bundela, P. S., Pandey, A. K., & Sarsaiya, S. (2010). Composting of municipal solid waste of Jabalpur City. *Global Journal of Environmental Research*, 4(1), 43-46.

- Hinckley, G. T., Johnson, C. J., Jacobson, K. H., Bartholomay, C., McMahon, K. D., McKenzie, D., ... Padersen, J. A. (2008). Persistence of pathogenic prion protein during simulated wastewater treatment processes. *Environmental Science Technology*, 42(14), 5254-5249.
- Huang, J., Yu, Z., Gao, H., Yan, X., Chang, J., Wang, C., ... Zhang, L. (2017). Chemical structures and characteristics of animal manures and composts during composting and assessment of maturity indices. *Journal in PLoS ONE*, 12(6), 1-16. doi.org/10.1371/journal.pone.0178110
- Islam, M. A., Boyce, A. N., Rahman, M., Azirun, M. S., & Ashraf, M. A. (2016). Effects of organic fertilizers on the growth and yield of bush bean, winged bean and yard long bean. *Brazilian Archives of Biology and Technology*, 59, 1-9. doi.org/10.1590/1678-4324-2016160586
- Kang, M. Y., Heo, K. H., Kim, J. H., Cho, S. S., Seo, P. D., & Rico, C. M. (2012). Effects of carbonized rice hull and wood charcoal mixed with pyroligneous acid on the yield and antioxidant and nutritional quality of rice. *Turkish Journal of Agriculture and Forestry*, 36, 45-53. doi.org/10.3906/tar-1001-640
- Karanja, M. P. (2015). *Suitability of waste water sludge for agricultural use: A case study of ruai sewage treatment plant, Nairobi, Kenya*, Unpublished master's thesis, Kenyatta University, Nairobi, Kenya.
- Kwaśny, J., Kowalski, Z., & Banach, M. (2011). Disposal methods and treatment of wastes from piggeries. *Chemik International*, 65(7). 687-696.
- Koenig, R., Cogger, C. G., & Bary, A. (2011). Dryland winter wheat yield, grain protein, and soil nitrogen responses to fertilizer and biosolids applications. *Applied and Environmental Soil Science*, 2011, 2-9. doi.org/10.1155/2011/925462
- Lowman, A., McDonald, M. A., Wing, S. & Muhammad, N. (2013). Land application of treated sewage sludge: Community health and environmental justice. *Environmental Health Perspectives*, 121(5), 537-542. doi.org/10.1289/ehp.120547
- Makan, A., Assobhei, O., Mountadar, M. (2013). Effect of initial moisture content on the in-vessel composting under air pressure of organic fraction of municipal solid waste in Morocco. *Iranian Journal of Environmental Health Science & Engineering*, 10(1), 2-9. doi.org/10.1186/1735-2746-10-3
- Mathias, J. F. C. M. (2014). Manure as a resource: Livestock waste management from anaerobic digestion, opportunities and challenges for Brazil. *International Food and Agribusiness Management Review*, 17(4), 87-11.

- Mathney, J. M. J. (2011). A critical review of the U.S. EPA's risk assessment for the land application of sewage sludge. *New Solutions*, 21(1), 43–56. doi.org/10.2190/NS.21.1.h
- Milla, O. V., Rivera, E. B., Huang, W., Chien, C., & Wang, Y. (2013). Agronomic properties and characterization of rice husk and wood biochars and their effect on the growth of water spinach in a field test. *Journal of Soil Science and Plant Nutrition*, 13(2), 251–266. doi.org/10.4067/S071895162013005000022
- Mofunanya, A. A. J., Ebigwai, J. K., Bello, O. S., & Egbe, A. O. (2015). Comparative study of the effects of organic and inorganic fertilizer on nutritional composition of *Amaranthus spinosus* L.. *Asian Journal of Plant Sciences*, 14(1), 34–39. doi.org/10.3923/ajps.2015.34.39
- Mojares, J. G. (2015). Implementing biogas technology project in Malvar, Batangas, Philippines. *Asia Pacific Journal of Multidisciplinary Research*, 3(4), 158-164.
- Ogbuewu, I. P., Odoemenam, V. U., Omede, A. A., Durunna, C. S., Emenalom, O. O., Uchegbu, U. C., ... Iloeje, M. U. (2012). Livestock waste and its impact to the environment. *Scientific Journal of Review*, 1(2), 17-32.
- Orge, R. F., & Leal, L. V. (2018). Utilizing heat from rice hull biochar production for steam pasteurization of mushroom fruiting bags. *Cogent Engineering*, 4, 1–12. doi.org/10.1080/23311916.2018.145397
- Pampuro, N., Preti, C., & Cavallo, E. (2018). Recycling pig slurry solid fraction compost as a sound absorber. *Sustainability*, 10, 2-13. doi.org/10.3390/su10010277
- Rizzardini, C. B., & Goi, D. (2014). Sustainability of domestic sewage sludge disposal. *Sustainability*, 6, 2424-2434. doi:10.3390/su6052424
- Rollo, E. P. F., Pabilona, L. L., Magomnang, A. S. M., Villanueva, E. P., Magomnang, D. M. M. (2017). Analysis of biogas production from cow, chicken and swine manure. *Mindanao Journal of Science and Technology*, 15, 130-136.
- Philippine National Standard. (2013). *Organic soil amendments*. Quezon City, Philippines: Department of Agriculture, Bureau of Agriculture and Fisheries Standards.
- Sarkar, S., Pal, S., & Chanda S. (2016). Optimization of a vegetable waste composting process with a significant thermophilic phase. *Procedia Environmental Sciences*, 35, 435–440. doi:10.1016/j.proenv.2016.07.026

- Song, C., Zhang, Y., Xia, X., Qi, H., Li, M., Pan, H., & Xi, B. (2018). Effect of inoculation with a microbial consortium that degrades organic acids on the composting efficiency of food waste. *Microbial BioTechnology*, 11(6), 1-13. doi.org/10.1111/1751-7951.113294
- Taiwo, A. M. (2011). Composting as a sustainable waste management technique in developing countries. *Journal of Environmental Science and Technology*, 4(2), 93-102. doi:10.3923/jest.2011.93.102
- Tibu, C., Annang, T. Y., Solomon, N., & Tawiah, D. Y. (2019). Effect of the composting process on physicochemical properties and concentration of heavy metals in market waste with additive materials in the Ga West Municipality, Ghana. *International Journal of Recycling of Organic Waste in Agriculture*, 8(4), 303-403. doi.org/10.1007/s40093-019-0266-6
- Uçaroğlu, S., & Alkan, U. (2016). Composting of wastewater treatment sludge with different bulking agents. *Journal of the Air & Waste Management Association*, 66(3), 288-295. doi.org/10.1080/10962247.2015.1131205
- Waszkielis, K. M., Wronowski, R., Chlebus, W., Bialobrzewski, I., Dach, J., Pilarski, K., & Janczak, D. (2013). The effect of temperature, composition and phase of the composting process on the thermal conductivity of the substrate. *Ecological Engineering*, 61, 354-357. doi.org/10.1016/j.ecoleng.2013.09.024