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Investigating the Effects of Reducing Pathogen Levels in Cow Dung as an Organic Fertilizer Feedstock

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ABSTRACT

Organic fertilizer plays a pivotal role in sustainable agriculture, offering an eco-friendly alternative to inorganic fertilizers with their adverse long-term effects on soil health and environmental balance. However, the presence of pathogens in organic waste, such as cow dung, poses significant challenges to composting efficiency, soil stability, and end-user health. Despite its importance, previous studies have often overlooked the necessity of assessing pathogen levels in selected feedstocks, thereby hindering the optimization of composting processes. This study addresses this gap by focusing on pre-treating cow dung as a feedstock for fertilizer formulation to reduce pathogen levels. Chemical oxygen demand (COD) and total solid (TS) analyses were conducted on both untreated and treated samples, following ASTM standards D6238 and D5231, respectively. Results showed a substantial reduction in COD from an initial value of 293.98 mg/L to 27.02 mg/L and degradation of TS from 303.78 mg/L to 53.74 mg/L, indicating efficient pathogen reduction. Additionally, the volatile solid (VS) removal efficiency during pretreatment was found to be 80.1 %. It is therefore concluded that, the treated cow dung to mitigate pathogen levels proved to be suitable for use as feedstock in organic fertilizer production. This is evidence from the significant reductions in COD, TS, and VS concentrations by 90.8 %, 82.3 %, and 80.1 % respectively.

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Introduction

The significance of organic fertilizer cannot be overstated, serving not only as a crucial tool in agricultural production but also as a viable alternative to inorganic fertilizers. Inorganic fertilizers, with their long-term detrimental effects on soil fertility, microbial activity, and natural environmental balance, underscore the importance of transitioning to organic alternatives as also reported by Adekunle *et al.* (2017). Research indicates that cow dung typically constitutes 80 % of organic fertilizer formulations, either as a primary feedstock or a carrier. However, it's crucial to note that cow dung contains pathogens, but previous studies have often overlooked the necessity of assessing pathogen levels in selected feedstocks, a critical factor affecting composting efficiency, overall stability for soil properties, and end-user health concerns (Babayemi and Dauda, 2019).

More so, high concentrations of pathogens in organic waste can impede beneficial microbial activity by competing for resources. Consequently, this interference with the composting process leads to suboptimal temperature levels within the system, resulting in prolonged decomposition times, diminished soil nutrient content, incomplete sterilization, and inadequate maturity of compost piles. Therefore, addressing pathogen levels in feedstocks is paramount to ensure efficient composting processes and the production of high-quality organic fertilizers. Pre-treating organic waste to reduce pathogen levels is an effective strategy to facilitate the composting process. This fosters the growth of beneficial microorganisms while inhibiting the survival of pathogens. This work is therefore aimed at pre-treating cow dung as a feedstock for fertilizer formulation to reduce the pathogen level.

Materials and Methods

Fresh cow dung was collected with a polyethylene bag from Zango abattoir, Zaria. It was then subjected to chemical oxygen demand, total solid, volatile solid, moisture content and the pH of the sample. The fresh cow dung was pre-treated by spreading them under direct sunlight for fourteen (14) days to reduce the moisture content which promote the pathogen load and their growth. During the drying process, the cow dung sample was

turned and mixed daily to ensure even drying, aeration, and breakdown of the clumps. The moisture content of the sample was monitored throughout the process. All the analysis carried out on the sample before treatment were also repeated on the treated sample. The chemical oxygen demand (COD) of the sample was determined using ASTM D6238 standard method as adopted from the work of Jianyong *et al.* (2021), the total solid (TS) analysis of the fresh cow dung was also determined by adopting ASTM D5231 standard procedure, in which Equation (1) was used to calculate the TS. This procedure was adopted from the work of Liu *et al.*, (2019).

$$\text{Total solid (TS)} = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

Where:

W_1 = Weight of empty crucible

W_2 = Weight of crucible with wet sample

W_3 = Weight of crucible with dry sample

The volatile solid (VS) analysis of the cow dung was determined using the ASTM D2972 standard method as adopted from the work of Safi *et al.*, (2018).

Results and Discussion

Chemical oxygen demand (COD) of the Cow dung

Table 1 shows the pretreatment analysis of the fresh cow dung, as observed from the analysis depicted in the table, the initial value of (COD) of the fresh cow dung used before treatment was 293.98 mg/L, which was reduced to 27.02 mg/L after the treatment. Therefore, the efficiency of the COD reduction in the cow dung used was 90.8 %, which is close to 91.2 % removal efficiency reported by Shiyang *et al.*, (2021). The significance of this reduction in the COD of cow dung before composting is to eliminate pathogens, thereby aiding microorganisms to easily break down the organic compounds, resulting in a more stable and mature compost. More so as reported in the work of Christian *et al.* (2018), composting with reduced COD levels improves nutrient availability and easily transforms the organic matter into a form that is more readily available to plants as nutrients. The COD reduction efficiency value obtained is in a good agreement with the standard range of 80-95% as reported by Liu *et al.*, (2019); Essam *et al.*, (2019); Meneses and Velazquez, (2020).

I. Table 1: Physicochemical analysis of the cow dung used

| Parameters | Before treatment | After treatment | % Difference |
|-------------------------------|------------------|-----------------|--------------|
| Chemical oxygen demand (mg/L) | 293.98 | 27.02 | 90.8 |
| Total solid (mg/L) | 303.78 | 53.74 | 82.3 |
| Volatile solid (mg/L) | 232.78 | 32.4 | 80.1 |
| pH | 6.4 | 6.02 | 5.9 |
| Moisture content (%) | 43.4 | 32 | 26.3 |

Total solid concentration of the Cow-dung

The total solid (TS) content of the cow dung manure was degraded from the initial concentration of 303.78 mg/L as shown in Table 1, to TS value of 53.74 mg/L which amounted to 82.3 % efficiency removal. As reported by Robert *et al.* (2019), if the concentration of total solids is too high, it can lead to a high C: N ratio and compacted compost thereby reducing the airflow and oxygen availability for the microorganism, which may slow down the composting process. Also, if it's too low, the compost may lack sufficient carbon for microbial activities. However, the value obtained as shown in Table 1 is in a close agreement with 80.13 % degradation previously reported by Gahyum *et al.* (2020). But this is lower than 94 % reported in the pretreatment investigation of chicken manure by Fontaine *et al.* (2020).

The higher degradation level reported in the work of Fontaine *et al.*, (2020) when compared with the present investigation is attributed to the high amino, polypeptide and protein contents in chicken manure that can be degraded easily to ammonia with the aid of denitrifying bacteria, compared to the cow manure that exhibits high content of cellulose because of their nature of food which is characterized by slower degradation processes, which is in accordance with previous work reported by Nopharatana *et al.* (2007). Thus, the trend in the degradation process of the TS

values throughout the investigation period is depicted in Table 2.

Table 2: Summary of the raw proximate analysis results trend of the fresh cow dung

| Parameters | Week 1 | Week 2 | Week 3 | Week 4 | % difference of initial and final values |
|-------------------------------|--------|--------|--------|--------|--|
| Chemical oxygen demand (mg/L) | 293.98 | 201.66 | 82.31 | 27.02 | 90.8 |
| Total solid (mg/L) | 303.78 | 247.01 | 102.20 | 53.74 | 82.3 |
| Volatile solid (mg/L) | 232.78 | 156.94 | 78.2 | 32.4 | 80.1 |
| pH | 6.4 | 6.3 | 6.2 | 6.02 | 5.9 |
| Moisture cont. | 43.4 | 41 | 35 | 32 | 26.3 |

Volatile solid (VS)

One of the factors affecting composting processes is low degradability of substrates. As shown in Table 1, the volatile solid efficiency removal during the cow-dung pretreatment is 80.1 %, which is close to the VS value of 84 % reported in the work of Animut *et al.* (2014). The high efficiency VS reduction as reported by Amimut *et al.* (2014) was stated to be contributed to fast degradation process of the substrate, thereby enhancing high yield of compost slurries. Based on this previous related result reported by Amimut *et al.* (2014) in comparable with the present work, it can therefore be said that; the high VS efficiency reduction obtained is a function of efficient degradation process that contributes to the high yield of organic nutrients. The reduction trends of VS raw result at every stage are also shown in Table 2.

Moisture Content and pH of the cow dung

As presented in Table 1, the initial pH and moisture content of the fresh cow dung were 6.4 and 43.4 % respectively. However, the changes in the pH and moisture content after treatment by drying process at the final week were 5.9 and 26.5 % respectively, which proved that, there is no significance changes in these properties. Table 2 also shows the moisture contents trends recorded during the study.

Conclusion

The investigation findings indicate that treated cow dung is suitable for use as feedstock in organic fertilizer production. This is supported by the significant reductions observed in COD, TS, and VS concentrations by 90.8 %, 82.3 %, and 80.1 % respectively. Furthermore, it was concluded that pre-treating the feedstock not only enhances the degradation process and yields higher organic nutrient content, but also improves airflow and oxygen availability to microorganisms within the system. This conclusion is supported by evidence showing a decrease in COD from 293.98 mg/L to 27.02 mg/L and TS from 303.78 mg/L to 53.74 mg/L after pre-treatment.

References

- Adekunle, R., Rasheed, A. and Ashira, R. (2017). Soil fertility challenges and Bio-fertiliser as a viable alternative for increasing smallholder farmer crop productivity in sub-Saharan Africa. 3(1400933). *Cogent Food and Agriculture*. doi.org/10.1080/23311932.2017.1400933. pg. 2 of 26 and 4 4 of 26
- Animut, A., Meseret, C. E. and Ameha, K. (2014). Thermal And Chemical Pre-Treatments Of Cow Dung And Poultry Litter Enhance Biogas Production In Batch Fermentation. *International Journal of Scientific and Technology Research*. Volume 3, Issue 11, ISSN 2277-8616. 165-166
- Babayemi, J. O. and Dauda, K. T. (2009). Evaluation of solid waste generation, categories and disposal options in developing countries: A case study of Nigeria. *Journal of Applied Science and Environmental Management*. 13(2). Doi: 10.4314/jasem.v13i355370
- Christian, O. S., Anthony, O. O., Chinedu, A. E., Patrick, U., Abiodun, A. O., Ikpotoke, I. and Micheal, I. (2018). Design and fabrication of an anaerobic digester for biogas production. *International Journal of Civil Engineering and Technology*. 9(11).
- Essam, I. H., Mohammad, R. A. and Yasser, E. N. (2019). Influence of biogas production on bioremediation of animal manures. *American Journal of Analytical Chemistry*. 2019(10). ISSN online: 2156-8278. Doi: 10.4236/ajac.2019.101001. Pg. 2-4.
- Fontaine, D.; Feng, L.; Labouriau, R.; Møller, H.B.; Eriksen, J.; Sørensen, P. (2020). Nitrogen and Sulfur Availability in Digestates from Anaerobic Co-digestion of Cover Crops, Straw and Cattle Manure. *Journal of Soil Science and Plant Nutrition*. 2020(20), 621–636.
- Gahyum, B., Danbee, K., Jinsu, K., Hanwoong, K. and Changsoo, L. (2020). Treatment of cattle manure by anaerobic co-digestion with food waste and pig manure. Methane yield and synergistic effect. *International Journal of Environmental Research and Public Health*. Doi: 10.3390/ijerph17134737. Pg. 3 of 13, 4 of 13 and 5 of 13.
- Liu, S.J., Xi, B.D., Qiu, Z.P., He, X.S., Zhang, H., Dang, Q.L., Zhao, X.Y. and Li, D. (2019) Succession and Diversity of Microbial Communities in Landfills with Depths and Ages and Its Association with Dissolved Organic Matter and Heavy Metals. *Science of the Total Environment*, 651, 909-916. <https://doi.org/10.1016/j.scitotenv.2018.09.267>
- Meneses, Q. O. and Velazquez, M. B. (2020). Pretreatment of animal manure biomass to improve biogas production: A review. *Journal of Bio-Energies*. 13(14). <https://doi.org/10.3390/en13143575>.
- Nopharatana A., Pullammanappallil, P.C. and Clarke, W.P. (2007). Kinetic and dynamic modelling of batch anaerobic digestion of municipal solid waste in a stirred reactor. *Waste Management Bulletin*. 27: 595-603.
- Robert, R., Maaten, V. K., Geoge, P. and William, F. B. (2019). On-farm composting handbook. *Northeast Regional Agricultural Engineering and Science*. 152 Riley-Rob Hall Cooperative Extension, Ithasa, NY. 1485-5781

Safi, J., El-Nahhal, Y. and Safi, M. (2018) Particle Size Distribution and Hydraulic Conductivity in Coastal Non-Agricultural Land in Gaza Coastal Plain. *International Journal of Geosciences*, 9, 619-633.
<https://doi.org/10.4236/ijg.2018.910037>

Shiyang, F., Anran, L., Annemiek, T. H. and Cees, B. (2021). Heat potential generation, recovery and utilization from composting. A review. *Journal of Resources Conservation and Recycling*. 175(2). Doi: 10.1016/j.resources.2021.