Journal of Smart Farming and Food Security
Universiti Malaysia Sabah, Malaysia

QUALITY OF ORGANIC FERTILIZER FROM GOAT DUNG

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Abstract:

Agricultural waste is commonly associated with agricultural plantations and refers to the waste produced from various farming operations. The composting process can reduce the amount of dung generated by livestock while also providing nutrients and organic matter to the soil when applied appropriately. Additionally, composting significantly reduces the odor and pest problems associated with dung. The number of goat farmers in Malaysia is increasing, along with the amount of waste produced, such as goat dung. Therefore, this study aimed to help us understand the preparation of the composting process and the composition of goat dung compost, as well as evaluate the effects of goat dung compost on the content of nitrogen (N), phosphorus (P), and potassium (K). A bedding system technique was used for the composting process. The parameters measured in this study were pH, temperature, and N, P, and K content. After 56 days, the goat dung compost reached maturity with a pH value of 6.84. It contained 3.1% N, 3.5% P, and 4.5% K, with a C/N ratio of 4:1.

***Keywords**: Bedding system, compost, goat dung, livestock, waste*

1. INTRODUCTION

The term 'agricultural waste' is commonly associated with agricultural plantations. Agricultural waste is defined as waste resulting from various agricultural activities. Waste generated on farms and in poultry houses includes crop residue, fertilizer runoff from fields, and pesticides that end up in water, air, or soil (Kallipso, 2023). Poor waste management in agriculture is considered one of the main contributors to environmental problems. As mentioned earlier, the expansion of agriculture is often accompanied by waste generated from the excessive use of intensive farming practices and the improper use of agricultural inputs, which have a significant impact on rural areas and the global environment. The nature of agricultural activities determines the amount of waste produced (Syamimi and Eeda, 2019). Agricultural waste management involves the processes of collecting, treating, and disposing of waste generated by agricultural activities.

Approximately 85% of the world's animal feces are produced by livestock, which is significantly higher than the total amount produced by humans. Animal waste management techniques in Malaysia are outlined based on the Department of Veterinary Services (DVS) standards from 2019. The Ruminant Waste Management Guideline (DVS, 2019) provides a framework for managing solid waste generated by ruminants. Solid waste, including manure and leftover animal feed, is dried and composted to produce organic fertilizer. The Goat Farming Waste Management Guideline (DVS, 2019) recommends various waste management strategies for goat farmers. Composting is one of the solid waste management techniques used on goat farms, while liquid waste is managed through screening, solids separators, composting, and settling ponds. Treating goat manure with microorganisms (EM) accelerates the decomposition of organic matter, improves composting, and minimizes odors. Additionally, treated sewage sludge can be dried and converted into manure.

Malaysian livestock farmers can obtain MyGAP certification under the Malaysian Standard MS 2027:2006 for Good Animal Husbandry Practices. This voluntary certification method emphasizes productivity, environmentally friendly livestock husbandry practices, farm biosecurity, disease management, and the production of safe, high-quality products for consumption. The guideline requires accredited farms to implement effective waste management, wastewater treatment, and control of pollution resulting from livestock production (e.g., flies, odor, dust, and noise) (MAFI, 2013). This initiative promotes proper waste management on livestock farms, benefiting producers, the nation, and the environment (Pathak *et al*., 2019). In 2021, the goat population in Malaysia was approximately 329,700, showing a slight increase from 324,000 goats the previous year (Statista, 2024). The goat population in Sabah was 54,464 (Malaysia Perangkaan Ternakan, 2018). As the number of goat farmers in Malaysia increases, so does the amount of waste produced, such as goat dung. If not properly managed, goat dung can contaminate the environment (Salwa *et al*., 2016).

Composting products made from animal waste, such as cow dung, goat dung, and chicken droppings, are widely used in the agriculture industry. Conservation farming practices like composting have the potential to significantly improve soil quality and environmental preservation. Composting is crucial in sustainable agriculture for converting organic matter into fertilizer or organic amendments that enhance soil fertility, control diseases, and promote healthy microbial populations. These benefits ultimately affect both the quantity and quality of crops and food. Composting is widely employed in both organic and conventional agriculture worldwide, demonstrating how the composting process is influenced by microbial succession and environmental conditions while promoting sustainable farming practices (Liu *et al*., 2022). Therefore, the findings of this study aim to help us understand the preparation and composition of the composting process of goat dung and evaluate the effects of the quality of goat dung compost on the nitrogen (N), phosphorus (P), and potassium (K) content.

2. MATERIALS AND METHODS

Goat Dung Compost Preparation

The bedding system was used for the composting process. The goat dung was sourced from the UMS FSA (Faculty of Sustainable Agriculture) farm. The dimensions of the bedding system were 3 feet high, 4 feet wide, and 8 feet long. In addition to the goat dung, additives such as rainwater were added. The water requirement was 50%-60% (7.5 L per irrigation), applied twice a week. The water frequency could be reduced as the compost neared maturity. The purpose of adding water was to adjust the moisture content, air permeability, and carbon-to-nitrogen (C/N) ratio, which are crucial for the microorganisms and fermentation process. The materials were mixed evenly using a modified mechanical compost turner. The compost pile was turned until fermentation was complete, with turning performed twice a week (on Mondays and Thursdays) (Jabatan Perkhidmatan Veteriner, 2019).

Parameters of Compost

pH and EC (Electrical Conductivity)

A 1:5 ratio was used for pH measurement. A 10 g sample of compost was tested with 50 ml of distilled water. The sample was shaken with an orbital shaker at 180 rpm for one hour. After shaking, the sample rested for an additional hour before the measurement. The pH was measured using the Eutech Instrument PC 2700. To ensure accuracy, the suspension was stirred for 3-5 minutes before taking the reading (FAO, 2018).

Temperature

The temperature of the compost was measured using a compost thermometer. The thermometer was inserted into the compost, and temperature readings were taken from the centre of the pile. Temperature data were recorded daily until the compost reached maturity (Streer et al., 2018).

Nitrogen (N), Phosphorus (P), and Potassium (K)

The method described by Chidambaram et al. (2013) was used to determine nitrogen (N) and phosphorus (P). For nitrogen, 20 g of the goat dung sample was placed in a flask with 20 ml of distilled water. Then, 100 ml of 0.32% potassium permanganate solution and 2 ml of 2.5% sodium hydroxide were added. The flask was heated, and 30 ml of the distillate was collected in 50 ml of N/50 sulfuric acid. The excess acid was titrated with an N/50 NaOH solution, using methyl red as the indicator.

For phosphorus, 1 g of goat dung was suspended in 200 ml of 0.002 N sulfurized water, shaken thoroughly, and filtered through Whatman No. 42 filter paper. Three drops of a 0.02% 2,4-dinitrophenol indicator were added to 10 ml of the filtrate. When the solution turned yellow, 2N sulfuric acid was added to remove the yellow colour. If the solution became colourless after adding the acid, 4N sodium carbonate was added until the solution remained colourless. Then, 2 ml of sulfomolybdic acid (prepared by mixing 25 g of ammonium molybdate in 200 ml, and 275 ml of concentrated H_2SO_4, diluted to 700 ml) was added. A 0.5 ml solution of chlorotinic acid (prepared by dissolving 25 g of $SnCl_2 \cdot H_2O$ in 50 ml concentrated HCl, diluted with water to 500 ml, and adjusted to 1.2 N HCl with water to 1L) was then added. The solution was mixed and made up to 50 ml. After shaking, the absorbance was measured using a UV spectrophotometer at 660 nm. A standard curve was prepared using potassium dihydrogen phosphate.

For potassium determination, the method described by Achikanu *et al*. (2013) was used. Ten grams of goat dung were placed in a flask with 50 ml of distilled water. Using a pipette, 5 ml of the sample was transferred (in duplicate) into a test tube. Two ml of columbal nitrite were added, and the mixture was shaken vigorously. The sample was left to stand for 45 minutes before being centrifuged for 15 minutes. The supernatant was drained, and 2 ml of ethanol was added. The sample was centrifuged again for 15 minutes, and the supernatant was drained. Then, 2 ml of distilled water was added to the residue, and the mixture was boiled for 10 minutes with frequent shaking. Afterward, 1 ml of 2% sodium iron (III) cyanide was added. The solution was shaken thoroughly, and the absorbance was measured at 620 nm against a blank.

Organic Matter and Moisture content

To determine the moisture content, first pre-weigh the crucible. Then, place 2-3 g of the sample (from the partially dried mass) into the crucible (d). The crucible containing the sample was then placed in an oven at 105°C for 24-48 hours until it reaches a constant weight. After the specified time, the crucible and the sample were weighed again (e) (Agriculture and Horticulture Development Board, 2025).

Formula for **moisture content % = (d-e) /d x 100**

To determine the organic matter, the samples were weighed (after the oven 105°C). Then the samples were placed in the oven for 3 hours at 550°C. After 3 hours, the furnace was turned off and the samples were allowed to cool for a few hours. Then the crucible and the remaining samples were weighed (Agriculture and Horticulture Development Board, 2025).

Formula for **total organic carbon % =** to measure the total carbon (TC) content of the sample, then subtracted with the inorganic carbon (IC) content to calculate the total organic carbon (TOC) content.

Formula for **Organic Matter % = Total organic carbon (%) x 1.72**

3. RESULTS AND DISCUSSION

3.1 Effects of temperature during the composting process

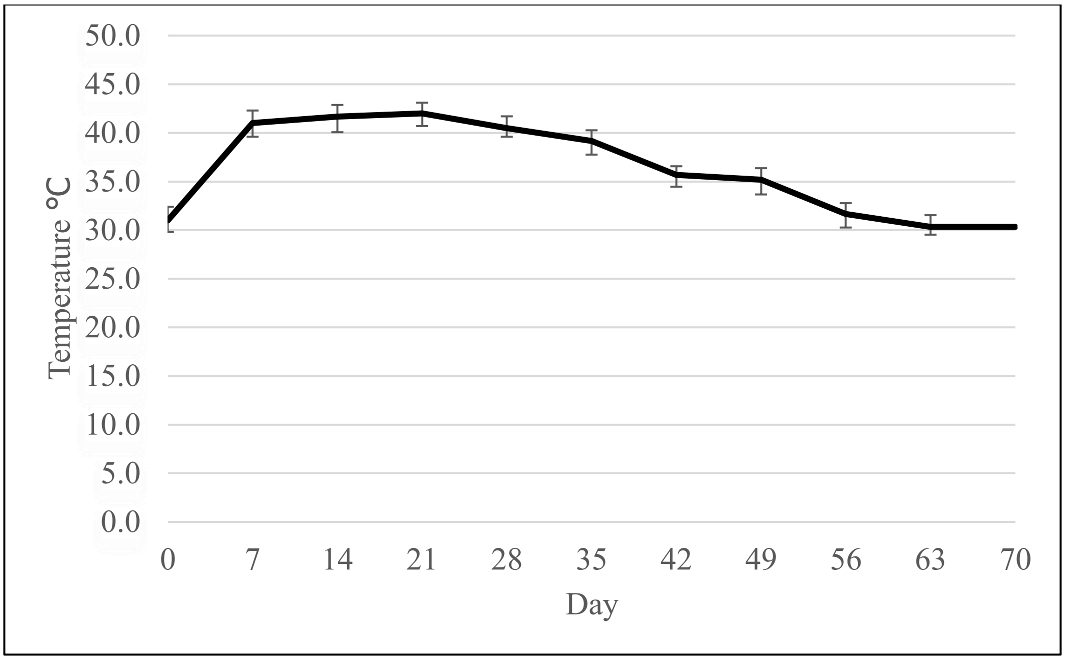

Figure 1: Temperature changes (°C) during the 70-day composting process. Error bars represent the standard deviation of the mean.

Figure 1 shows that on day 0, the temperature was 31°C, which falls within the mesophilic stage (0°C - 40°C) of the composting process for goat dung. Between days 7 and 21, the temperature increased, entering the thermophilic stage (40°C - 60°C), with temperatures ranging from 40°C to 46°C. However, by day 27, the temperature began to decrease, signalling the transition into the second mesophilic stage (maturing stage), where temperatures ranged from 0°C to 40°C. This indicated that the compost was starting to mature. The goat dung compost reached maturity after approximately 56 days, as the temperature stabilized at 35°C. However, to ensure the compost was stable and fully matured, we extended the process until day 70. Temperature was monitored daily as it is a critical factor influencing the composting rate, particularly when substrate availability is not limited. Figure 1 illustrates the temperature fluctuations during the goat dung composting process. An increase in temperature indicates microbial activity, which is responsible for decomposing the organic waste (Puastuti, *et al*., 2021). The compost reached thermophilic temperatures within the first 3 days, with the highest temperatures of 43°C and 46°C recorded on day 16. The compost remained within the thermophilic range (<46°C) for over 30 days. By week 5, the temperature of the goat dung compost began to gradually decrease. On day 35, the temperature had dropped to 38°C and continued to decline until it reached 33-31°C on day 70.

The increase in temperature during the first 30 days indicates that the decomposition process was progressing rapidly. During this period, the compost temperature remained relatively stable, suggesting that the organic waste decomposition was consistent. After 30 days, the temperature began to decrease gradually, signalling that the organic matter was nearing completion. Mature goat dung compost typically has a temperature between 30°C and 35°C.

The decline in temperature indicates that microbial activity has slowed down due to the depletion of available organic material, marking the transition into the cooling phase.

At the end of the experiment, the goat dung compost was considered mature after 56 days because the temperature had stabilized at 35°C. Previous studies indicate that cold dung releases nutrients more slowly, enhancing their availability to plants. Goat dung typically has a lower nitrogen content compared to other fertilizers, such as chicken or cow dung, which generates more heat during composting (Katherine, 2020). In general, dried dung has a higher nutrient concentration than fresh dung. However, during composting, some nitrogen is lost to the air or washed away by rain, reducing the amount available to plants (Adekiya *et al*., 2020).

3.2 Effects of pH during the composting process

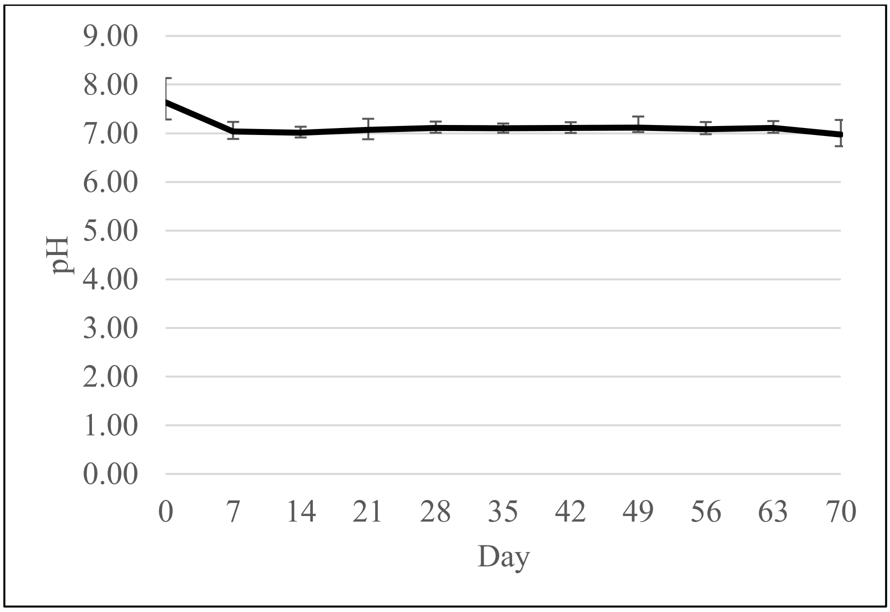

Figure 2: pH changes during the 70-day composting process. Error bars represent the standard deviation of the mean.

Figure 2 shows the pH value of the goat dung compost was highest at 7.63 after 0 days and lowest at 7.01 after 14 days. Goat dung composts had the highest initial pH, which could be because the dung had a high pH (pH > 7). The pH of the goat dung compost initially decreased and reached the lowest value on day 16, but then increased and reached maximum values between 7.0 and 7.10 on days 21 to 63. After day 63, the pH value started to slow down from 7.1 to 6.84 at 70-Day. The goat dung compost was consistently stagnant and exhibited alkaline pH values during composting, which could be attributed to the increased release of ammonia during the biodegradation of organic compounds. According to the previous research, the composted goat dung had a pH value of 7.8, while fresh goat dung had a pH value of 8.9. Organic acids are formed early in the decomposition process. The acidic conditions promote the development of fungi and the decomposition of lignin and cellulose. As composting progresses, the organic acids are neutralized and the mature compost usually has a pH of 6 to 8 (Ndung'u *et al*. 2021). Decrease in pH could be due to microbial activities that change the chemical composition of the dung, especially the formation of organic acids (Irshad *et al.,* 2018). The observed trend in compost pH of the compost, where the pH initially decreased and later increased, was in agreement with a similar trend reported by Ndung'u *et al.* (2021). In goat dung compost, the initial decrease in pH could be due to the production of organic acids during the early stages of composting, while the increase most likely reflects the microbial decomposition of the organic acids and the release of alkali and alkaline earth metals that were previously bound in the organic matter (Ramadevi *et al.,* 2023). According to Ahmed's 2019 research, goat dung is cold, has a more balanced pH and contains less salt. It is also drier than chicken droppings and falls to the ground in nice, small pellets that resemble rabbit droppings but are slightly larger. These pelleted droppings allow more air into the composting dung pile and compost faster due to their dry nature. The increase in pH of goat dung compost could also be due to the ammonification process when organic material is broken down (Ramadevi *et al.,* 2023). The ammonia produced increases the pH during the thermophilic phases of composting. The decrease in pH after the increase can be attributed to the nitrification process, which is always accompanied by the release of hydrogen ions (Li *et al.,* 2023).

3.3 Effects of EC (Electric Conductivity) during the composting process

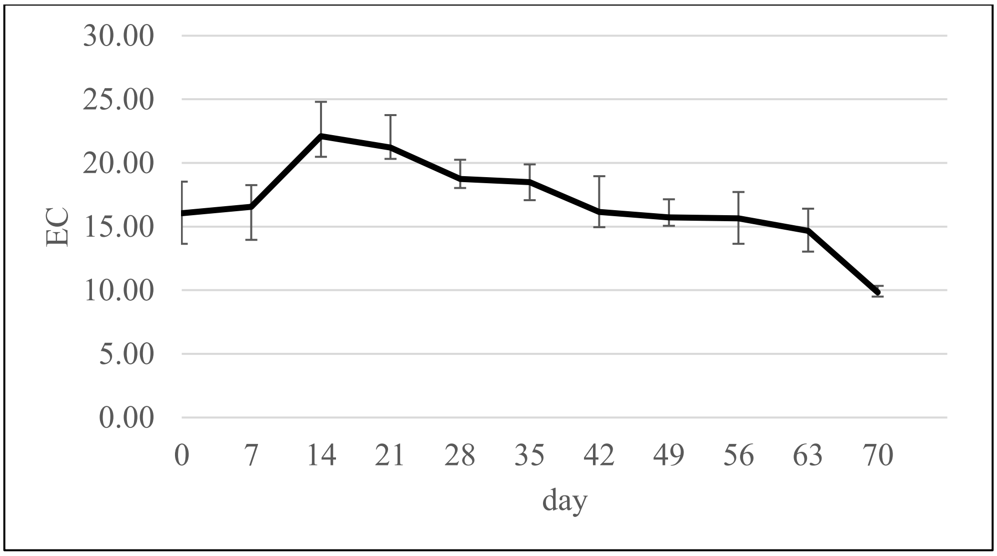

Figure 3: Effects of EC during the 70-day composting process. Error bars represent the standard deviation of the mean.

Figure 3 shows that the electrical conductivity (EC) value at day 0 was 16.05 mS/m, while on day 14, it increased to 22.10 mS/m, marking the highest average EC value observed during the composting process. By day 28, the EC value began to decrease, dropping to 18.75 mS/m. Between days 35 and 70, the EC value continued to decline, ranging from 18.48 to 9.84 mS/m. According to research by Irshad et al. (2018), the EC of dung increases significantly during composting, particularly in goat dung, where the EC typically ranges from 10.3 to 10.6 mS/m. This increase is likely linked to the conversion of biological materials into inorganic forms. Even after the composting process, the EC value in goat dung compost remains relatively high, ranging from 16.05 to 9.84 mS/m. The elevated EC values in composted dung may be attributed to the gradual release of salts over time. Changes in EC values can also serve as an indicator of compost maturity. Electrical conductivity measures the total cations and anions in a solution, often dominated by Mg and Ca ions (Gong *et al*., 2018). The observed increase in EC can likely be attributed to the decomposition of organic matter and the higher content of soluble mineral salts that become more accessible during the composting of goat dung (Kavita & Vinod., 2019). Furthermore, the increased EC associated with higher amounts of goat dung suggests a greater presence of cations, particularly in treatments with more than 50% goat dung. However, the impact of different cations, especially Na, from various composts, may require further investigation under field conditions to assess their effects on soil physical properties (Abakumor *et al*., 2018).

3.4 Effects of nutrient composition on goat dung compost

Table 1: Nutrient Composition of Goat Dung compost

Property	Raw Goat Dung	Goat Dung Compost
Moisture content (%)	37.65	29
pH	8.5	6.84
Nitrogen, N (%)	3.12	3.17
Phosphorus, P_2O_5 (%)	3.18	3.55
Potassium, K_2O (%)	4.02	4.58
Organic matter (%)	58.41	36.12
C (%)	40.62	27.73
C:N Ratio	13:1	4:1

The results in Table 1 show that the nutrient composition of macronutrients in goat dung significantly influences the composting process. Initially, goat dung contains about 3.12% nitrogen (N), but after composting, the nitrogen content increases to 3.17%. This increase is due to the naturally lower nitrogen content in goat dung, which is impacted by microbial activity during composting. Microorganisms break down the organic material and convert it into plant-available forms. As a result, the carbon-to-nitrogen (C/N) ratio decreases, indicating a higher concentration of nitrogen relative to carbon as the composting progresses (Asteria *et al*., 2021). The phosphorus (P) content in raw goat dung was 3.18%, and it increased to 3.55% after composting. This increase occurs because organic phosphorus is converted into inorganic forms, making it more available to plants (Rivka and Nur, 2024). Similarly, the potassium (K) content in raw goat dung was 4.02%, and it slightly increased to 4.58% after composting. Microbial decomposition releases potassium from the organic matter, enriching the resulting compost (Rivka and Nur, 2024). The organic matter in raw goat dung was highest, with an average of 58.41%, while the organic matter in goat dung compost was 36.12%. Although the organic matter decreased after composting, it can still provide valuable nutrients during the process. This decrease in organic matter highlights that goat dung contributes important nutrients for plant growth. These nutrients are crucial for the microbial cells involved in the process of reforming the organic matter in the soil (Fatimah *et al*., 2021). Regarding the C/N ratio, the ratio in goat dung after composting was lower than that of raw goat dung. This decrease is due to the degree of decomposition during the composting process. As organic waste undergoes biooxidation, carbon is lost as CO_2, and nitrogen is slowly lost as the organic fraction turns into an inorganic form. These changes help stabilize the compost. This finding aligns with recent research showing that goat dung has a low C/N ratio, which accelerates the decomposition process. The lower the C/N ratio, the shorter the time required for composting (Zhu *et al*., 2021).

4. CONCLUSION

In conclusion, the production of goat dung compost resulted in a final pH value of 6.84, which falls within the optimal range for farming, between 5.5 and 7.5. Additionally, the compost reached the appropriate temperature for maturity, around 29-30°C, after 70 days of the composting process. The findings of this study indicate that goat dung compost typically contains 3.17% nitrogen (N), 3.55% phosphorus pentoxide (P_2O_5), and 4.58% potassium oxide (K_2O), with a C/N ratio of 4:1. Composting goat dung is an effective waste management strategy for reducing volume, and enhancing soil health and fertility. Furthermore, this research highlights the economic benefits of developing organic fertilizers and promoting environmentally friendly agricultural practices. Therefore, goat dung compost can be safely applied to plants, as its nutritional value provides significant benefits to both soil and crops, regardless of the type of dung used.

ACKNOWLEDGMENTS

Financial assistance was provided by Research Grant (DKP0054- Organic Fertilizer from Goat Dung as an Environment-Friendly Organic Fertilizer and Economic Value to Sabah Using Commercial Composting. In recognition their invaluable support, the authors are grateful to Ms. Rasyiqah Mustamin, Ms. Nurain Nabilah Bt L U Jamil, Mr. Syamil Akmal Bin Kamis and Mr.Andreas Ariun Vivian

REFERENCES

Abigail (2021). Compost Maturity and Stability. Copyright Authenticae 2024. https://www.authenticae.co.uk/post/compost-maturity-and-stability. Accessed on 8 October 2024

Achikanu CE (2013) “Determination of the Vitamin and Mineral Composition of common Leafy Vegetables in South Eastern Nigeria”. International Journal of Current Microbiology and Applied Science 4.11: 347-353.

Adekiya A. O., Ejue W. S., Olayanju A., Dunsin O., Aboyeji C. M., Aremu C., *et al.*. (2020). Different organic dung sources and NPK fertilizer on soil chemical properties, growth, yield, and quality of okra. Sci. Rep. 10:16083. doi: 10.1038/s41598-020-73291-x

Ahmet Emrah Erdogdu [a], Refik Polat [a], Gunay Ozbay [b] (2019). Pyrolysis of goat dung to produce bio-oil. Engineering Science and Technology, an International Journal. Volume 22, Issue 2, Pages 452-45. https://doi.org/10.1016/j.jestch.2018.11.002

Alfred Grand (2020). Compost: Advantages and Disadvantages. https://www.best4soil.eu/assets/factsheets/7.pdf. Accessed 18 March 2024

Amrit Lal Meena, Minakshi Karwal, Debashis Dutta, R.P. Mishra (2021). Composting: Phases and Factors Responsible for Efficient and Improved Composting. Agriculture & food: E- Newsletter (Volume 3- issue 01) pages 85-86

A. Neh (2020), “Agricultural Waste Management System [AWMS] in Malaysian,” J. Waste Manag. Xenobiotics, vol. 3, no. 2

Asteria Aili, Ndiipohamba Katakula, Bethold Handura, Werner Gawanab, Fisseha Itanna, Hupenyu Allan Mupambwa. Optimized vermicomposting of a goat dung-vegetable food waste mixture for enhanced nutrient release. Scientific African Volume 12. https://doi.org/10.1016/j.sciaf.2021.e00727

E.V. Abakumor, 0.A. Rodina, A.K. Eskov (2018). Humification and humic acid composition of suspended soil in oligotrophous environments in South Vietnam. Applied and Environmental Soil ScienceVolume 2018, Issue 1. https://doi.org/10.1155/2018/1026237

Baltrus, D. A. (2017). Adaptation, specialization, and coevolution within phytobiomes. *Curr. Opin. Plant Biol.* 38, 109–116. doi: 10.1016/j.pbi.2017.04.023

Bhale UN., et al. "Physico-chemical parameter of Organic Compost and its impact on Pigeon Pea Crop Plants Productivity". IOSR Journal of Pharmacy and Biological Science 13.2 (2018): 74-79.

Chinweuba AJ., et al. "Comparative Analysis of Macro and Micro nutrient of Bio waste, compost and Vermicompost (Using indigenous Lumbricus terrestis) solanum melongena (fruit) waste" Journal of Science and Engineering Research 4.3 (2017): 102-331.

Chidambaram ALA., et al. "Effect of Vermicompost on the growth and Nutrient Status in Groundnut (Arachis hypogaea. L)". Asian Journal of Plant Science and Research 3.2 (2013): 15- 22.

Chu, H., Sun, H., Tripathi, B. M., Adams, J. M., Huang, R., Zhang, Y., et al. (2016). Bacterial community dissimilarity between the surface and subsurface soils equals horizontal differences over several kilometers in the western Tibetan Plateau. Environ. Microbiol. 18, 1523–1533. doi: 10.1111/1462-2920.13236

C. Yeates, M.R. Gillings, A.D. Davison, N. Altavilla and D.A. Veal (1997). PCR amplification of crude microbial DNA extracted from soil. Microbiology 25(4):303-7. DOI:10.1046/j.1472-765X.1997.00232.x

D. Surtina1 , R.M. Sari1 , T. Astuti 1 and A.H. Kusuma (2019). The Effect of Using Some Kind of Dung on the Content of Dry Matter, Organic Matter and Crude Protein of Elephant Grass Cv. Taiwan (Pennisetum purpureum) on the First Harvest. IOP Conf. Series: Earth and Environmental Science 347. doi:10.1088/1755-1315/347/1/012010

Dynamic Consultancy. Determining plant dry matter (DM) & Moisture. https://www.dynamicag.com.au/wp-content/uploads/2015/12/DM-fact-sheet-v2.pdf.

DVS. (2019). Chicken Farming Waste Management Guideline. Department of Veterinary Services (DVS).

DVS. (2019). Ruminant Farming Waste Management Guideline. Department of Veterinary Services (DVS).

Ebele Rita Emendu1*, Arinze Jude Chinweuba2, Onuorah Chinedu Chibuzor3 and Nnamdi Benneth Emendu (2021). Analysis of Micro and Macro Nutrient Levels in Compost and Vermicompost Fertilizer Formulated from Selected Agro-waste and Comparative Assessment of the Fertilizer Efficiencies. Acta Scientific Nutritional Health (ISSN:2582-1423)

Ezeorji OO., et al. "Utilization of Organic waste in the Production of Biofertilizer (by vermicompost using Eisenia fetida Earthworm) with the Analysis of their Micro and

Macro Mineral Nutrient and their effects on Growth Rateof Fruited Pumpkin (Telfairia occidentalis) and Spinach (Spinacia oleracea)”. Acta Scientific and Nutritional Health 4.2 (2020): 01-10.

Glossary of Environment Statistics, 2018 https://unstats.un.org/unsd/environmentgl/.

Gomathi. S, (2023). Goat dung natural composting at plant growth. Department Of Bio-Technology School Of Bio And Chemical Engineering Sathyabama Institute Of Science And Technology (Deemed To Be University).

Irshad, M., A. E. Eneji, Z. Hussain and M. Ashraf (2018). Chemical characterization of fresh and composted livestock dungs. Journal of soil science and plant nutrition version On-line ISSN 0718-9516. http://dx.doi.org/10.4067/S0718-95162013005000011

Kallipso (2023). What Is Agricultural Waste Management? Plastic Recycling Company for UK Businesses. https://www.plasticexpert.co.uk/what-is-agricultural-waste-management/

Katakula, C, Asteria Aili Ndiipohamb, Bethold Handura, Werner Gawanab, Fisseha Itannac,d, Hupenyu Allan Mupambwaa,∗ (2021). Optimized vermicomposting of a goat dung-vegetable food waste mixture for enhanced nutrient release. Article in Scientific African. DOI: 10.1016/j.sciaf.2021.e00727

Katherine Drovdahl (2020). Normal Goat Temperature and Goats Who Don’t Follow the Rules. Get a temperature reading before starting goat antibiotics. https://goatjournal.iamcountryside.com/health/normal-goat-temperature. Accessed on 23 December 2024

Kavita Sharma & Vinod Kumar Garg (2019). Recycling of lignocellulosic waste as vermicompost using earthworm *Eisenia fetida*. Environmental Science and Pollution Research. https://doi.org/10.1007/s11356-019-04639-8

Kinyua, M., Rowse, L., & Ergas, S. (2016). Review of small-scale tubular anaerobic digesters treating livestock waste in the developing world. Renewable and Sustainable Energy Reviews, 58, 896-910.

Kishneth Palaniveloo, Muhammad Azri Amran, Nur Azeyanti Norhashim, Nuradilla Mohamad-Fauzi, Fang Peng-Hui, Low Hui-Wen, Yap Kai-Lin, Looi Jiale, Melissa Goh Chian-Yee, Lai Jing-Yi, Baskaran Gunasekaran and Shariza Abdul Razak (2020). Food Waste Composting and Microbial Community Structure Profiling. https://www.mdpi.com/2227-9717/8/6/723

Li G., Li M., Wu M., Li Z. (2022). Effects of chemical fertilizer combined with organic dung on Peanut rhizosphere bacterial community structure and co-occurrence network. Soil 54, 498–507. doi: 10.13758/j.cnki.tr.2022.03.009

Li, Z.; Yang, Y.; Xia, Y.; Wu, T.; Zhu, J.; Wang, Z.; Yang, J. The succession pattern of bacterial diversity in compost using pig dung mixed with wood chips analyzed by 16S rRNA gene analysis. BioRxiv 2019, 674069.

Lim KC, Zaharah AR (2023) The effects of oil palm empty fruit bunches on oil palm nutrition and yield, and soil chemical properties. J Oil Palm Res 14:1–9

Lin Y., Ye G., Kuzyakov Y., Liu D., Fan J., Ding W. (2019). Long-term dung application increases soil organic matter and aggregation, and alters microbial community structure and keystone taxa. Soil Biol. Biochem. 134, 187–196. doi: 10.1016/j.soilbio.2019.03.030

Li X., Su Y., Ahmed T., Ren H., Javed M. R., Yao Y., et al.. (2021). Effects of different organic fertilizers on improving soil from newly reclaimed land to crop soil. Agriculture 11:560. doi: 10.3390/agriculture11060560

Liu, X., Zhang, J., Gu, T., Zhang, W., Shen., Q., Yin, S., & Qiu, H. (2014). Microbial community diversisties and Taxa abundances in soils along a seven-year gradient of potato monoculture using high throughtput Pyrosequencing Approach. PLOS ONE, 9:1-10

Liu U., *et al.* "Effects of Nitrogen Fertilizers on the Growth and Nitrate Content of Lettuce (Lactuca sativa L.)". International Journal of Environmental Resources and Public Health 11.4 (2014): 4427-4440.

MAFI. (2021). Executive Summary National Agrofood Policy 2.0 2021-2030. Ministry of Agriculture and Food Industry (MAFI)

Maffei, D.F., E.Y. Batalha, M. Landgraf, D.W. Schaffner, and B.D. Franco. 2016. Microbiology of organic and conventionally grown fresh produce. Brazilian Journal of Microbiology 47: 99–105.

Malaysia Perangkaan Ternakan (2018). bilangan Ternakan di Malaysia. https://www.dvs.gov.my/dvs/resources/user_1/2019/BP/Perangkaan%20Ternakan%20 20182019/1)_Malaysia_Perangkaan_Ternakan.pdf.

Marion Shepherd (2007). The microbiological analysis of composting. https://tigerprints.clemson.edu/cgi/viewcontent.cgi?article=1146&context=all_theses

Ministry of Housing and Local Government. (2013, October 15). Statistic on average of solid waste generation in each state. Available at http://www.kpkt.gov.

Mongjam S., et al. "Effect of Compost and Vermicompost Prepared from different Bioderadable Waste on the Growth of King Chilli Capsicum Chinense". International Journal of Plant, Animal and Environmental Sciences 9.2 (2019): 74-82.

Nandhini E and Sumathi S. "Conversion of Solid Waste into Bio fertilizer by Vermicompost Method" International Journal of Pharma Science and Research 8.3 (2017): 24-32

Ndung'u, M., Ngatia, L.W., R.N. Onwonga, M.W. Mucheru-Muna, R. Fu, D.N. Moriasi, and K.F. Ngetich. 2021. The influence of organic and inorganic nutrient inputs on soil organic carbon functional groups content and maize yields. Heliyon 7. https://doi.org/10.1016/j.heliyon.2021.e07881

Nilesh Mahajan, Rohini Kharwade, Payal Badole (2023). Development of pharmaceutical aids from agricultural and other wastes. 360-Degree Waste Management, Volume 1 Fundamentals, Agricultural and Domestic Waste, and Remediation. https://doi.org/10.1016/B978-0-323-90760-6.00006-0

Nurul Nadia Fatiha Yaacob, Latifah Abd Manaf & Zulfa Hanan Ash'aari (2019). Quantifying The Organic Waste Generated From The Fresh Market In Kundasang Town, Sabah. Journal of the Malaysian Institute of Planner. Volume 17 issue 2 (2019). DOI:10.21837/pmjournal.v17.i10.633

Nurul Syamimi Fauzi and Nor Eeda Haji Ali. Agricultural Waste Management (Awm) System In Mukim Ulu Telom, Cameron Highlands, Pahang. Green management, paper code: CG005. https://ir.uitm.edu.my/id/eprint/40229/1/40229.pdf

Pathak, P., Mandavgane, S., & Kulkarni, B. (2019). Waste to wealth: a case study of papaya peel. Waste and Biomass Valorization, 10(6), 1755-1766

P. Rao and V. Rathod (2018), "Valorization of Food and Agricultural Waste : A Step Towards Greener Future," Chem. Rec., no. 18, pp. 1–15

Ramadevi S, Sivaranjani S, Vijaya Samoondeeswari S, (2023). Comparative study of organic dung (cow dung, goat dung and chicken manuare) on the vegetative growth of *Amaranthus dubius* L. AGBR.2023;39(4):1-7.

Salwa Adam, Syed Saiful Nashrizam Syd Ahmad, Nur Masriyah Hamzah and Noor Azimah Darus (2016). Composting of Empty Fruit Bunch Treated with Palm Oil Mill Effluent and Decanter Cake. Regional Conference on Science, Technology and Social Sciences (RCSTSS 2014) (pp.437-445)

Samanhudi., P. Harsono., E. Handayanta., R. Hartanto., A. Yunus., M. Rahayu., dan S. M. Iswara. 2020. Respon Pertumbuhan dan Hasil Tanaman Sorgum Manis (Sorghum bicolor L.) terhadap Pemberian Pupuk Organik di Lahan Kering. Prosiding Webinar Nasional Series: Sistem Pertanian Terpadu dalam Pemberdayaan Petani di Era New Normal: 217-234.

Statista. Goat stock in Malaysia from 2013 to 2022. https://www.statista.com/statistics/659810/malaysia-goat-dung. Accessed on 25 October 2024

Streer, Paul, and Rochester. 2018. Directions for Using a Tel-Tru Dial Type Bimetal Thermometer.

Takemura Electric Works (2024). Takemura Electric Works DM-15 Soil pH Tester User Guide. https://manuals.plus/takemura-electric-works/dm-15-soil-ph-tester-manual.

USDA (U.S. Department of Agriculture) (2023). Dung Management. https://www.ers.usda.gov/topics/farm-practices-management/crop-livestock-practices/dung-management/#:~:text=Dung%20management%E2%80%94how%20dung%20is,the%20need%20for%20commercial%20fertilizer.

W Puastuti, D Yulistiani and Y Widiawati (2021). Nutrient content and greenhouse gas emissions of goat dung compost processed without and with decomposer. IOP Conf. Series: Earth and Environmental Science 648 (2021) 012113 IOP Publishing doi:10.1088/1755-1315/648/1/012113

Yathiender S., et al. "A Comparative Study of the Effect of different Potting Mixture on Growth of *Zea May* L. and *Trigonella foeruimgraecum* L". International Journal of Environment Resources and Public Health 11.4 (2018): 44274440.