The Effect of Animal Products Versus Organic Products on the pH Level of Leachate Produced by Anaerobic Fermentation

Abstract

This research focused on the reduction of household food waste through sustainable disposal methods, and the implication of the resulting material, specifically how it can further be applied to agricultural methods. Moreover, the purpose of this project was to determine if the pH levels of leachate produced by anerobic fermentation would be affected by the contents undergoing fermentation (animal products vs. organic products). Previous work has identified the importance of nutrient rich soil (the product of using additives such as compost or fermented material) for healthy and improved plant growth but tends to overlook the importance of pH and determining what inputs will best improve soil health, and therefore plant health. Furthermore, the conducted experiment aimed to gain an understanding of the impacts of different inputs undergoing anerobic fermentation, and in turn how this would affect pH levels. This was done through two experimental groups differing in their inputs, one containing animal products and the other containing organic products, which both underwent anerobic fermentation and were monitored over the course of three weeks and checked every three days during the three week period. Overall, results showed that animal products sustained a neutral pH at 6.71, and organic products had an average pH of 4.57 (generally considered very acidic for soil ideal for plant growth). The implications of the experiment and its results are as follows: applying research studying sustainable agriculture both on a small and large scale---whether its at home, beginning a compost bin that could potentially provide a nutrient rich, natural additive for soil and future plants; or replacing widely-used, harmful farming methods (synthetic pesticides and fertilizers) to improve soil health, which benefits plants and animals alike.

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- **Research Question**: The purpose of this project was to determine if the pH levels of leachate produced by anerobic fermentation would be affected by the contents undergoing fermentation (animal products versus organic products).

- **Variables:**
    - **Independent variable**: the contents undergoing anerobic fermentation, consisting of two experimental groups: animal product and organic products.
    - **Dependent variable**: The pH level of leachate produced from either experimental group

Background research

Introduction Rational

Research concerning the different factors that can determine a soil's health is important because it enables scientists to understand what contributes the most to healthy soil. Furthermore, healthy soil is the framework for healthy plants, and plants are what grow food for human consumption. Especially now as population on Earth increases, figuring out new technology and methods that are efficient and sustainable for higher yielding crops is crucial to the health and wellbeing of the planet as well as the planet's population. Applying research with evidence that displays, for example, what conditions are favorable for nutrient rich soil and what can increase a soil's microbial activity to increase the soil's overall health is an essential step in the direction of sustainable solutions and innovations for current and future agricultural practices.

Furthermore, an experiment which tested the effect of compost on soil microbiomes found that compost "significantly reduced Fusarium oxysporum (a plant pathogen) and increased bacterial abundance." (LeBlanc and Harrigian, 2024). In addition to this, the author proceeds to state that the study has "technical implications for future research focused on linking soil

microbiome characteristics with pathogen suppression or other processes relevant to agriculture." (LeBlanc and Harrigian, 2024). This research displays with graphs the elevated levels of bacterial abundance, bacterial diversity, bacterial richness, and decreased levels of pathogen abundance to demonstrate the many benefits that compost has on overall soil health. However, though this research shows that compost likely suppresses plant pathogens and increases microbial activity, it does not show how this affects plants actively growing in the soil.

This leads to the next experiment, which tests compost's effect on the growth of Zinnia plants. As predicted, Zinnia plants grown in soil mixed with compost, specifically 50% compost, grew more than plants in soil mixed with 25% or 100% compost. Plants specifically in the 50% compost group grew more in areas including height, stem diameter, number of leaves per plant, length of branches, and number of flowers per plant. This evidence would support the claim that compost encourages healthy soil, and due to this, plants grown in said soil also experience benefits, because "compost is believed to directly influence plants through hormonal mechanisms and indirectly affect soil microorganisms, leading to enhanced nutrient uptake and improved soil properties, ultimately promoting plant growth and productivity." (Qayyum, 2024).

So, as displayed by the research and evidence formerly given, compost likely has many positive impacts on soil health, from benefits such as increased nutrient levels and faster, increased plant growth, to pathogen suppression and increased microbial activity. In addition to compost, exploring other sustainable and environmentally friendly alternatives to methods used in agriculture for increased crop yields—such as GMOs and synthetic fertilizers—is important. One of these alternative methods could be worms. How do worms affect soil health as compared

to compost? Earthworms specifically provide many benefits to soil health, including earthworm tunnels that bring in oxygen and drain water, creating space for plant roots, as explained by the U.S Department of Agriculture. “They feed primarily on organic material in soils, eating fresh and decaying material from plant roots…as they feed, they move and mix their waste with the soil in a moist, microbe-rich environment” (Avant, 2025). Earthworms may also work as a sort of indicator species for determining soil health in field crops.

The potential societal impacts of researching and learning more about compost and other sustainable agricultural practices would hopefully include making urban populations more aware of the problems that stem from industrial agriculture and how it affects the environment. The implementation of compost, especially on a smaller scale (such as in individual households and community gardens) can minimize food waste and create a healthy, natural environment for plant growth. Of course, compost and worms are not the complete solution to reshaping agricultural practices, but further research on their benefits and application of them could potentially be a step in the direction of sustainable agriculture and an overall healthier environment.

Material List

- Two 5 gallon Ace Hardware buckets to store waste
- Fruit and vegetable/ meat and dairy waste from household for fermentation
- 5 lbs. bag Bokashi bran (EM Premium Bokashi Compost Starter)—added to buckets with waste to facilitate fermentation process
- Flinn pH testing strips to test leachate
- 2 Mason jars for storage of leachate
- Measuring tools for measuring amount of collected leachate

Experimental procedure

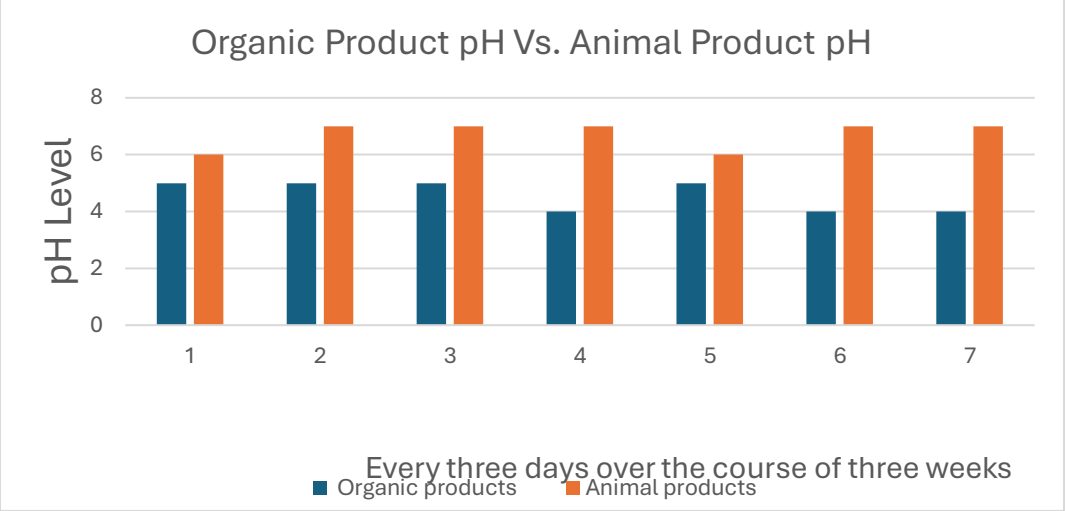
1. Two 5 gallon Ace Hardware buckets were filled with roughly the same mass of either fruit and vegetable waste or meat and dairy waste to begin experiment

2. Fruit, vegetable, dairy, and meat waste products were collected from general household waste, sorted and disposed of in their respective bucket
3. 1 Tablespoon of EM Premium Bokashi Compost Starter was added to each bucket for approximately 1 inch or food waste
4. Buckets were sealed tightly after opening
5. Each day both buckets were filled with roughly the same mass of waste for their respective category, with the corresponding amount of bran added as well
6. Every three days the leachate that forms in the bottom of the buckets was collected and stored in two separate Mason jars
7. Process repeated itself for 3 weeks
8. At the end of the experimental phase a final sample of leachate was collected from either bucket and tested for pH levels, N, P, and K levels
9. Results were inserted into a graph to be analyzed
10. After each time dealing with organic material/bokashi bran/leachate, hands were wet with clean, running water
    a. Hands were then lathered with soap
    b. For at least 20 seconds, hands were scrubbed
    c. Hands were then rinsed under clean, running water again
    d. Lastly, hands were dried using a clean towel or air dry

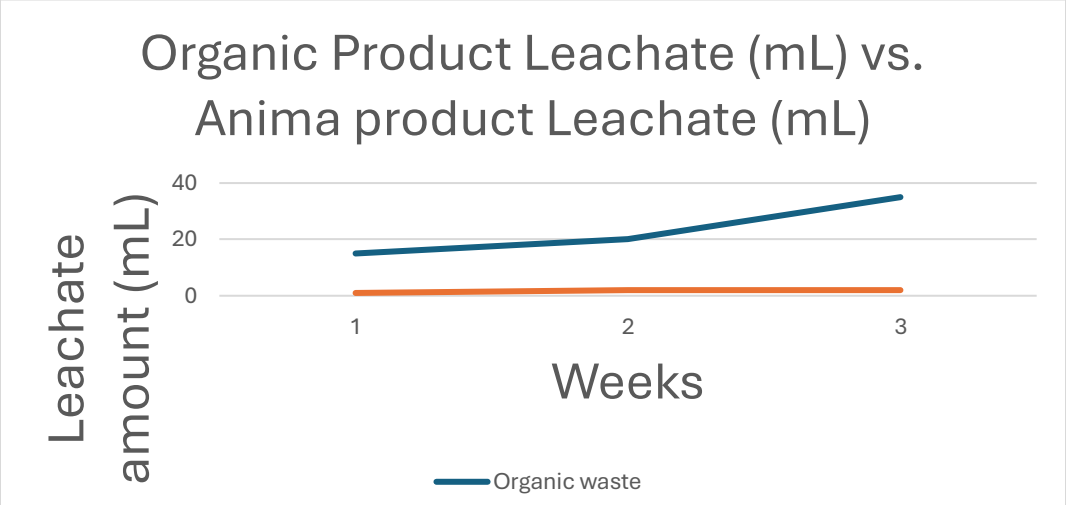
Procedure for pH testing:

1. One Flinn pH testing strip was dipped into collected leachate from fermentation process
2. Flinn pH strip was held in liquid for required amount of time
3. Flinn pH testing strip was shaken off to get rid of excess liquid
4. Result color was revealed (0-14 scale) and compared to pH strips from former days and from opposite experimental group
5. Results were recorded

Data Analysis and Discussion



Comparing the trends in leachate pH levels between organic products and animal products displays that animal product leachate (consisting of meat and dairy products), has the higher pH level. pH levels of both experimental groups remained somewhat constant over the course of three weeks, never altering even after new food waste was added to each bucket, and time fermenting appearing to have no effect on the pH level of the leachate.



Comparing the amount of leachate produced by the animal products group (orange line) to the amount of leachate produced by the organic products group shows that it was significantly less, possibly due to the higher water content that fruits and vegetables have. This water content is around 85%-95% of fruit and vegetable weight, while meat products and dairy products (like cheese) possessing a water content ranging from 60-75% for meat products and 35-38% of water content in common dairy products like cheddar cheese.

Conclusions

- Claim: Animal products undergoing anerobic fermentation will produce leachate with a consistently neutral pH level
- The results of animal products fermenting, which could further be added to compost and then soil to improve abundance of microorganisms and nutrients, in terms of pH level are more suitable to undergo these further steps than the results of organic products fermenting
- Evidence: Comparing both experimental groups, the animal product group had an average leachate pH level of 6.71
- The organic products group had an average leachate pH level of 4.57
- Reasoning: Identifying that the animal products group consistently had a neutral pH level, and the organic products had a significantly more acidic pH level, adding fermented animal products to compost and then to soil would be more beneficial to the soil and potential plants growing in the soil overall.

Ideas for future research

- Expanding on the qualities tested in fermented animal products versus fermented organic products (nutrient levels, microbial activity)
- Testing the pathogen prevention of natural soil applicants versus synthetic soil applicants

Annotated Bibliography

Margaritis, Markos, et al. “An Experimental Investigation of the Composting Process in an Innovative Home Composting System: The Influence of Additives.” *Cleaner Materials*, vol. 8, Jun. 2023, p. 100185. *ScienceDirect*, https://doi.org/10.1016/j.clema.2023.100185.

This study looks at different additives that can be added to home composting units and how these additives affect the compost that is produced mostly in terms of nutrient levels. In addition to this, one of the study’s goals is to inform the reader of household food waste and its significance, and to make the reader aware of the simplicity of a home composting unit that with some additives, such as woodchips or organic matter, and some leftover food, compost can easily

be made and reduce food waste produced from individual households. However, the specific experiment conducted in this study was partly insignificant to the issue of household food waste. The characteristics that were measured in the produced compost almost seemed irrelevant to the message the author was trying to convey.

LeBlanc, Nicholas R., and Fiona C. Harrigian. “Green Waste Compost Impacts Microbial Functions Related to Carbohydrate Use and Active Dispersal in Plant Pathogen-Infested Soil.” *Microbial Ecology*, vol. 87, no. 1, 2024, p. 44. *PubMed Central*, https://doi.org/10.1007/s00248-024-02361-8.

In this study, the effects of compost on soil microbiomes and specifically plant pathogens are researched. The author’s aim is to inform the reader of the possibly beneficial effect compost can have on suppressing harmful pathogens in plants. The author conducts the experiment by adding different levels of compost to soil with an artificially made pathogen and observes and measures the outcomes. Consistent with the hypothesis, the pathogen in the soil with a higher percentage of compost was significantly reduced. Concluding, the author explains that research looking at compost and its affects on soil microbiomes can further current knowledge on the topic, thus making it more applicable to the real world to benefit crops and soil health.

admin. *Home Composting and Compostable Plastics | Faculty of Engineering*. https://www.ucl.ac.uk/engineering/home-composting-and-compostable-plastics. Accessed 9 Sep. 2025.

This study looks at the reality of compostable plastics and packaging at home. The experiment is conducted with households from across the UK and numerous different packaging

products that claim to be “biodegradable” or “home compostable.” What the results show is that after the set period of time letting the different products break down in home composting units, 66% of the items tested still had remains that were visible. This leads the author to conclude that many of these products are not fully biodegradable or compostable, and might actually require industrial composing instead of composting done at home. However, this study does not specifically state the period of time for which the products were given to break down in participants’ compost, and therefore it is hard to conclude whether the products are compostable or not. In addition to this, because research was conducted at almost 1,000 different homes across the UK, there are of course many uncontrollable factors that may have interfered with the experiment and the validity of the results. This experiment could be done again in a more controlled environment with possibly a smaller range of items for its results to be more reliable.

Qayyum, Muhammad Mazhar, et al. “Effect of Compost on the Growth, Flowering Attributes, and Vase Life of Different Varieties of Zinnia (Zinnia Elegans).” *Journal of Applied Research in Plant Sciences*, vol. 5, no. 02, Jun. 2024, pp. 259–68. *joarps.org*, https://doi.org/10.38211/joarps.2024.05.278.

This study looks at compost’s effect on different varieties of a species of bush/tree. The goal of this research is to show that compost may be beneficial to the growth of plants including the pace at which they grow, the height to which they grow, the number of flowers and leaves they produce, and many other parameters mentioned in the study. The results of this experiment show that when soil is mixed with 50% compost, the plants show significantly more growth in most of the growth parameters (compared to 25% and 100%, for example) that were being measured. In

addition, one variety of the plant used did better in 50% compost compared to the other two varieties used. This extra variable in the study seems unnecessary, however, because to solely focus on the effects of compost on a plant species, one variety should be used instead of multiple so that there is not a confounding variable. In this case the multiple varieties of the species of plant distracts away from what the author is trying to show, which is that compost is beneficial on the growth of plants. Simply using different mixtures of compost as they also did in this study would have been enough of an independent variable.

Manrique-Veja, Silvia Melissa, and Oscar Alvarado-Sanabria. "Compost Increases Soil Fertility and Promotes the Growth of Five Tropical Species Used in Urban Forestry." *Floresta e Ambiente*, vol. 30, no. 3, Dec. 2023. *doaj.org*, https://doi.org/10.1590/2179-8087-floram-2023-0018.

Similar to the previous study, this study's goal was to show the benefits of using compost in soil, in this case on tree growth. This study focused on how compost affected the growth of the trees, but also how the compost affected the soil, measuring factors such as nutrient levels, pH, and microbiological activity. The results of this study show that trees with a substrate of 12.5% compost grew significantly more than the control group, and also that substrates with added compost displayed increased conductivity, pH, and an overall higher nutrient level.