Olfactory relief in Laramie, WY: Altered Composting Efficiency and Microbial Community in Aerated and Covered Compost Piles

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Objectives

- To further our understanding of the effects of aeration, variation in carbon input (increased brown matter), and covering of compost piles on microbial population, composting time, water content, pH level, temperature, C:N ratios and odor.
- To create a more efficient and cost-effective method of composting that reduces gas emissions for ACRES student farm to use.

Hypotheses

1. Additional brown matter in the form of shredded office pack (paper) added to the starting compost test piles will reduce the odorous smell of the piles, the time to compost, and will increase the pH and *Actinomycetes* populations.
2. Covering the piles will result in a higher moisture content, thus decreasing time to compost and increasing *Actinomycetes* populations.
3. An aeration system within the piles will increase pH and reduce anaerobic microbial populations and odor.

Introduction

According to the Environmental Protection Agency, food waste is the largest contributor to landfills .To reduce this waste locally, ACRES student farm on the University of Wyoming campus composts 840 gallons of food waste every week. The ACRES student farm is a volunteer-run community outreach organization through the University of Wyoming that grows fresh vegetables for the community of Laramie. ACRES is a prime example of a small, urban farm that uses organic and sustainable practices. Urban agriculture has been suggested as a solution for several inner-city problems, so any solutions found here in Laramie, WY could serve as a model for other cities.

However the smell of the compost has gotten to the point that the farm has received threats of relocation or the termination of the composting program. This would be a great loss to the Laramie community as ACRES provides food donations to local charitable organizations. The purpose of this project was to save the farm by minimizing the composting odors. Much work has been done characterizing the most effective and least odorous methods of composting. An imbalance in temperature, pH, aeration, moisture content, microbial diversity, C:N ratio, or ammonium levels can lead to the production of odorous volatile organic compounds (VOCs) such as acetoin and butandione.[4,7] Compost piles should have a surface temperature of 50-105° F and an internal temperature between 110° and 150°F.[4] Species like *Lactobacillus* produce foul-smelling acids under anaerobic conditions, so proper aeration is crucial. Additionally, samples with lower nitrate and TVOC concentrations tend to be less odorous.[5,7] Moisture levels should be between 40% and 60% to provide enough water for the fungi and bacteria to thrive, but not enough to create anaerobic environments.[4] The presence of aerobic bacteria such as *Actinomycetes* indicates a healthier, less odorous compost pile.[7] Despite the 2:1 biomass ratio of fungi to prokaryotes, there are relatively few papers devoted to the fungal component of compost.[1] However, it is known that fungal balance is pivotal to the overall success of decomposition. Carbon-Nitrogen ratios are important to providing the bacteria with the basic components of life; too much carbon means the bacteria do not have enough nitrogen to continue growing, while an excess of nitrogen is turned into smelly compounds.[4] Since straw amendment from the previous season had not broken down efficiently a new carbon source, shredded office pack could provide the needed carbon more efficiently. Efficient compost piles will take a shorter amount of time to become soil than those with an imbalance of one of the above factors.[4]

Malodor problems can be fixed with extended infrastructure, but ACRES requires cheap solutions with a minimal time input. Different methods of aeration, covering and brown matter content, as suggested by earlier findings, were manipulated in test piles as possible solutions to the odor problem (**Figure 1**). Populations of *Lactobaccili, Actinomycetes* and fungi as well as ammonia and nitrate levels, pH, temperature, and composting progress were monitored (**Figure 2**). We hope that economically minimizing the odor emanating from the compost piles will allow ACRES to continue providing vegetables to the Laramie community while simultaneously acting as a model for other urban farms facing the same problem.

Methods: Pile Composition

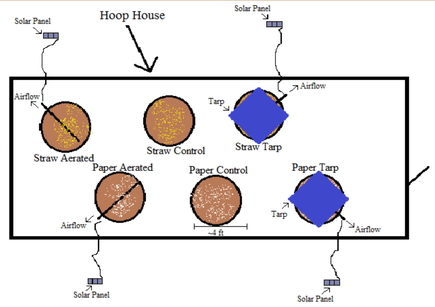

Figure 1:
1:2 scaled pile layout schematic. Not drawn to scale. The hoop-house was utilized to mimic summer conditions under which composting can occur. All piles were watered with one can of water on Sunday after cores were taken. Additionally starting at Time 3 the Control and Aerated piles received an additional can of water on Wednesday. Two buckets of water were also added to increase ambient moisture. Note, aeration pipes are pointed outward to prevent drying of adjacent piles.

Figure 1a:
Picture of the initial unaltered piles in the hoop-house.

Methods: Lab Procedure

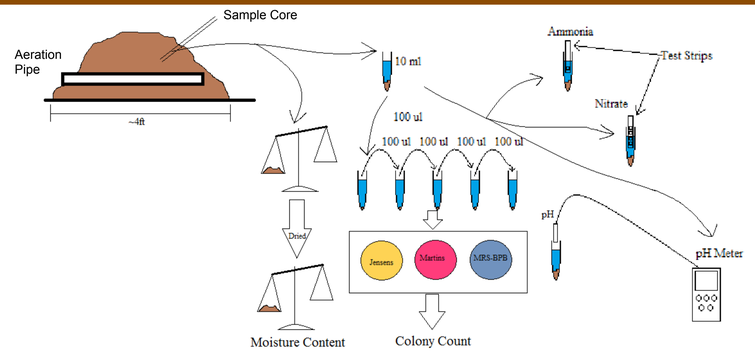

Figure 2:
Diagram of procedure. Cores were taken from the piles. A fraction of the core was dried to obtain percent moisture content. 1 gram of compost was floated in water until it reached a total of 10 ml. To measure microbial populations serial dilutions were made from the floats and plated on selective medias. Jensens grew *Actinomycetes*, Martins grew fungi, and MRS-BPB grew fermenting *Lactobacillus*. Additionally ammonia, nitrate and pH were measured from the floats.

Results

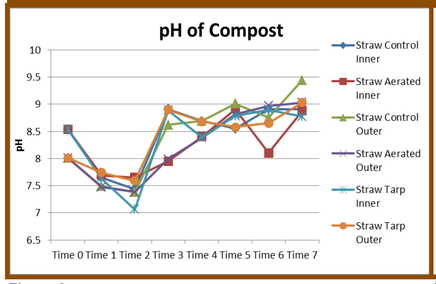

Figure 3:
pH of compost over the course of the experiment, showing a general increase over time. There was no observable difference between Straw and Paper piles.

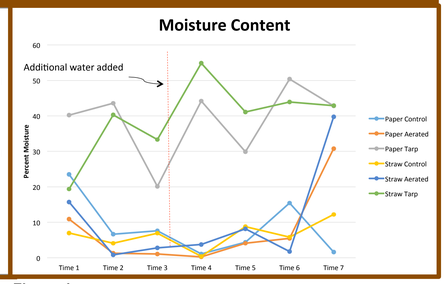

Figure 4:
Moisture content of the piles over the course of the experiment. The covered piles show a distinctly higher moisture content compared to the non-covered piles.

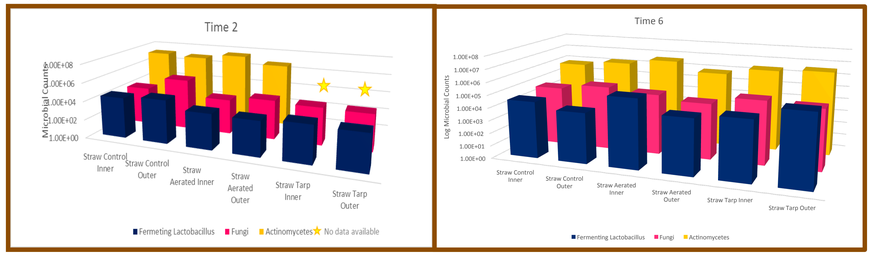

Figure 5:
Microbial composition at Time 2 and Time 6 showing increased *Actinomycetes* compared to *Lactobacilli* and fungal populations.

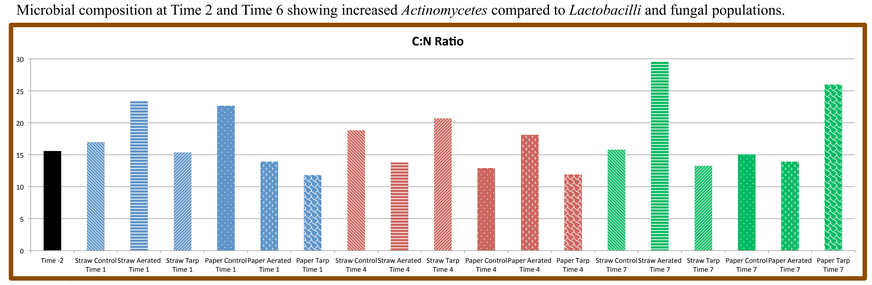

Figure 6:
C:N ratios from all piles over three time points. The black column is from the starting material with none of our amendments. While most variation is likely due to sampling bias, the C:N ratio is higher than the previous study.

Results

- The tarp-covered piles had observably higher moisture contents than the other piles (**Figure 4**).
- All populations remained stable over the course of the experiment (**Figure 5**).
- All piles had higher concentrations of *Actinomycetes* than fermenting *Lactobacilli* (**Figure 5**).
- There was no detectable vomit smell in any of the piles after two weeks of treatment, despite being strong initially.
- There were no differences in microbial composition, moisture, pH, or C:N between the Inner and Outer layers or between the Paper and Straw amended piles.
- No differences were seen in ammonia and nitrate between the Inner and Outer layers or between Paper and Straw amended piles.
- The pH of the piles increased over time (**Figure 3**).
- At the end of the study the covered piles yielded compost with a darker color and fewer large particulates.
- The C:N ratio was higher than pervious study, but still remained below optimal 30:1 ratio (**Figure 6**).

Conclusion/Discussion

- Implementing a similar covering and aeration scheme would likely improve ACRES composting process.
- Hypothesis 1 was not supported. The type of brown matter did not effect the composting process, therefore ACRES does not necessarily need to alter their supplemental carbon source.
- Hypothesis 2 was mostly supported. Covering definitively increased moisture retention.
- Color and lack of particulates indicates that the covered piles had produced a higher quality compost over the duration of the study. These findings provide rudimentary evidence for more efficient composting.
- Hypothesis 3 was not supported. Aeration piles were not drastically different from the controls. However, we can not say that a tarp alone without aeration will yield positive results similar to those achieved in this study.
- The levels of pH, *Actinomycetes* populations, fermenting *Lactobacillus* populations, and the quality of the compost at the end of the experiment demonstrated that the tested methods were successful at increasing composting efficiency.

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