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The Effect of the Pyramid Shape on Compost Smell

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Cover Page Footnote

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Abstract

SUNY Geneseo's campus has a compost collecting program where students, faculty, and staff can dispose of their compostable items in bins which are emptied weekly. However, the bins release a putrid scent when opened, deterring SUNY Geneseo community members from using them. A phenomenon commonly known as Pyramid Power claims that the pyramid shape, when exactly scaled to the size of the Great Pyramid of Giza, has properties that, once compostable items are put under it, can limit the growth of microorganisms and therefore reduce the foul smell. Using a 3-D printing device, we will scale and print the pyramid to the size of the current compost buckets. Then, we will test if microorganism growth and foul scent is decreased inside the pyramid shape as compared to inside the current compost bucket design.

Introduction

The Great Pyramids of Egypt are very mysterious structures. Their sheer size is impressive as well as their shape, which is very precise; the length of each side of the pyramid deviates by less than two feet from one another (Toth & Nielsen, 1985). Because of this, many theories have arisen about these structures. For example, investigation into the Orion Correlation Theory reveals that the relative positions of the three pyramids of Giza coincide with the positions of the three stars in the Orion's Belt constellation (Orofino, 2014).

The idea that the pyramid shape contains a mystical power with many different properties was first established by Antoine Bovis (1935/2006), a Frenchman in the early 1900s. It is suspected that in the early 20th century Bovis visited the Cheops pyramid and noticed a garbage can filled with dead animals (Flanagan, 1973). The animals, although having been in the chamber for a long period of time, showed no rot and had no foul smell, as if they were mummified. This sparked Bovis' experiments using a cardboard pyramid under which he was able to mummify a dead cat. His further experiments on various foods showed that the pyramid structure could also reduce decomposition speed.

Other, more recently discovered properties of the pyramid shape, include its ability to make foods taste less bitter and acidic, sharpen razor blades, and stimulate psychic pow-

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ers (Toth & Nielsen, 1985). It is unknown what causes the pyramid structure to contain these properties, but it is suspected the pyramid's response to the Earth's magnetic field plays a role, hence why in many pyramid power experiments the pyramid structure used is aligned exactly along the Earth's N–S magnetic field line (Flanagan, 1973).

It is important to note that Bovis' trip to the Giza pyramids cannot be proven, which brings skepticism to his work. No primary source can confirm he was there. Bovis himself claims he only knew of the precise measurements and location of the pyramids, which sparked his beliefs and experiments (Bovis, 1935/2006). Regardless, scientists still conduct research with pyramid power and some successful experiments suggest its validity.

Mathematical Anomalies

The Great Pyramid has unusual mathematical properties. Pi and Euler's number are all contained within the pyramid shape.

Finding Pi

In a ratio of $\frac{2r}{h}$, the output is approximately $\pi \approx 3.14$, accurate to two decimal places. The measurements used are those of the Great Pyramid.

$$\begin{aligned} \frac{2r}{h} &\approx \pi \\ \frac{2 * 755}{481} &\approx \pi \\ 3.14 &\approx \pi \end{aligned} \tag{1}$$

Since our pyramid is scaled to the Great Pyramid, it should have a similar output, with slightly more error due to rounding. However, it is still accurate to two decimal places.

$$\begin{aligned} \frac{2r}{h} &\approx \pi \\ \frac{2 * 12.957514}{8.255052} &\approx \pi \\ 3.14 &\approx \pi \end{aligned} \tag{2}$$

Finding Euler's Number

Euler's number, $e \approx 2.72$, can be found in the angles of a vertical cross-section of the Great Pyramid. Because of scaling, these angles are the same in the Great Pyramid and in our model.

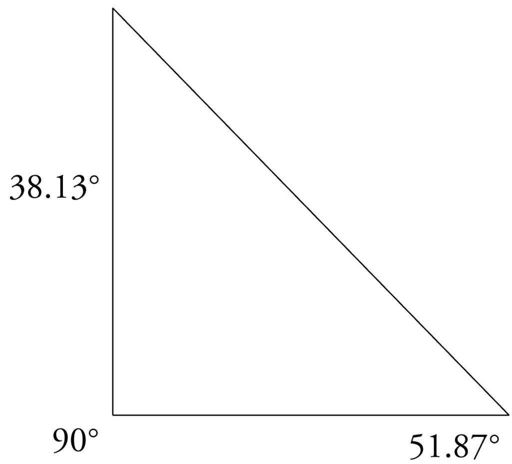


Figure 1: Half cross-section of the Great Pyramid with angles.

By multiplying a ratio of 51.87° to 38.13° by 2, we find Euler's number, accurate to two decimal places.

$$2 * (\frac{51.87}{38.13}) \approx e$$
$$2.72 \approx 2.72 \tag{3}$$

Literature Review

Since Bovis' trials, few experiments have been conducted using the pyramid shape. Karel Drbal deduced that using the pyramid shape over razor blades allowed them to be sharp for 111 shaves when they could normally be used for about five (Loxton, 2006). A patent was granted for this discovery, with the pyramid's effects providing "enhanced quality" to the blades after placing them under a "hollow pyramid...oriented along the axial line N–S coinciding with the direction of the lines of force of the magnetic field of the world" (Semenovich, 1995).

More recent experiments have yielded mixed results. An Indian research team yielded similar success with an experiment which tested the effect of the pyramid shape on the growth and emergence of fenugreek seeds (Kumar & Nagendra, 2011). They used two square pyramids, one made of fiberglass and another of plywood. Only the wooden pyramid showed statistically significant data that fenugreek growth and emergence was increased by being placed under the pyramid shape. However, placing fenugreek seeds under both plywood and fiberglass pyramids still had a positive influence on their emergence and vigor as compared to a control sample which had no pyramid over it.

There have also been tests related to food preservation and microbial growth. Investigation of the pyramid shape's ability to preserve milk was done by an Indian research team using square pyramid shapes and octagonal pyramid shapes of fiberglass and plywood (Nagaraja et al., 2008). The data showed statistically significant evidence of reduced bacteria growth when milk was placed under wooden pyramids, but not under the fiberglass pyramids. The octal forms of the pyramid performed better than the square forms. This data does not support the hypothesis tested in this experiment, since a square, plastic pyramid will be used. A similar experiment also tested the pyramid shape's effect on bacterial growth in milk using wooden and fiberglass pyramids of varying shapes (Kumar et al., 2005). They found that conical pyramids were more effective than flat-roofed structures and that plastic structures were more effective than wooden ones. More investigations need to be held to show if their data was statistically significant. These results support the hypothesis in this experiment.

Current Compost Buckets

The current compost buckets used at SUNY Geneseo are a rectangular frustum shape with a handle and lid (Figure 2).

Figure 2 Example of the current personal and department compost bucket design.

The dimensions are as follows:

Table 1:
Measurements of the Current Personal and Departmental Compost Buckets

Measure	Measurement
Base Length	6 in
Base Width	5.5 in
Top Length	8 in
Top Width	7.5 in
Side Length	13 in
Volume	2 gal

Dimensions of the Great Pyramid

The Great Pyramid of Giza is a square pyramid. Its approximate dimensions will be used in following calculations and are as follows (Toth & Nielsen, 1985):

Table 2:
Approximate Measurements of the Great Pyramid of Giza

Measure	Measurement
Base Length	755 ft
Height	481 ft
Volume	90,000,000 ft^3
Side Face Base Angle	51.8°

Computations

To find the volume of a pyramid, we used the following formula with *r* being the length of the bases and *h* being the height of the pyramid:

$$V_{pyramid} = \frac{1}{3}\pi r^2 h \tag{4}$$

We need to scale our pyramid to the exact size of the Great Pyramid. Since we did not know the exact height, *h*, and base length, *r*, that we want to use, we created a ratio of the two to eliminate one of the variables within the original volume formula.

$$\begin{aligned} \frac{h}{r} &= \frac{481}{755} \\ \frac{h}{r} &= .637 \\ h &= .637r \end{aligned} \tag{5}$$

Using this ratio, we can eliminate the variable *h* from equation 4.

$$\begin{aligned} V_{pyramid} &= \frac{1}{3}\pi r^2 h \\ V_{pyramid} &= \frac{1}{3}\pi r^2(.637r) \\ V_{pyramid} &= .212632r^3 \end{aligned} \tag{6}$$

The current compost buckets hold a volume of 2 gallons, which is equal to 462 square inches. Plugging this into our formula we find:

$$\begin{aligned} V_{pyramid} &= .212632r3 \\ 462 &= .212632r3 \\ r &= 12.957514 \end{aligned} \tag{7}$$

Lastly, we used our calculated *r*-value and equation 2 to solve for *h*.

$$h = .637r$$
$$h = .637 * 12.957514$$
$$h = 8.255052$$

(8)

To check that this data is correct, we used a tangent function, $tan(\theta) = \frac{O}{A}$ where $A = \frac{1}{2}r$, $O = h$, and θ = angle of base of pyramid cross section. The base angle of the Great Pyramid is approximately equal to 51.8°.

$$tan(\theta) = \frac{O}{A}$$
$$tan(\theta) = \frac{8.255052}{6.478757}$$
$$tan^{-1}(\theta) = tan^{-1}(\frac{8.255052}{6.478757})$$
$$\theta = 51.87° \approx 51.8°$$

(9)

There is a slight margin of error due to rounding (.00144 < α = .05). Therefore, the new compost bucket design is a square pyramid with *r* ≈ 12.96 in and *h* ≈ 8.26 in (see Figure 2).

The addition of a lid is necessary to use the pyramid as a bucket. The lid was placed at $\frac{2}{3}h$ for ease of cleaning and handling the bucket. The pyramid is printed in two pieces (Figure 3).

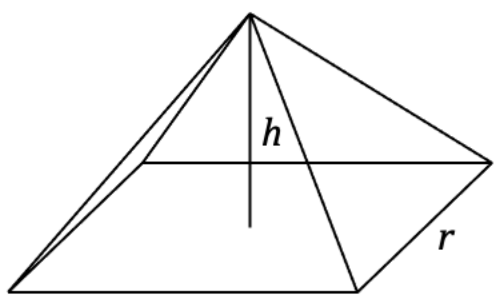


Figure 3: New compost bucket design to scale (scale = 0.25).

It is created using a 3-D printing device out of Polylactic Acid (PLA). The lid is attached with a movable hinge and there are protrusions that can support a handle (Figure 4).

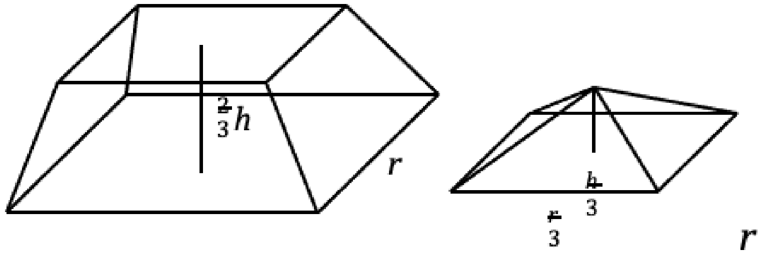
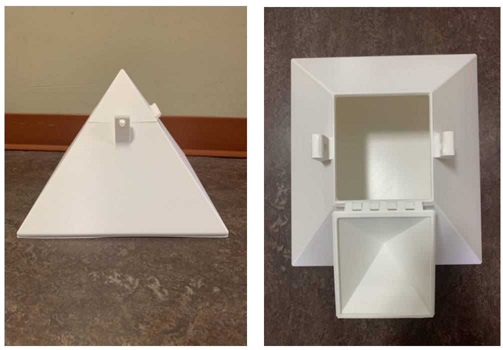


Figure 4: New compost bucket design with base (left) and lid (right) to scale (scale = 0.25).



New compost bucket design.

Methodology

Decomposition was compared between the original and new compost bucket design. Each bucket had the same compostable materials (i.e., banana peels, apple cores, cooked foods, paper compostable trays, etc.) and the same quantities of those materials. Samples were held in the same conditions (i.e., temperature, humidity) and collected within 10 minutes of each other.

A scent test included 11 test subjects. Subjects were asked to smell the compost immediately after it was placed in the current compost bucket design (control) and rate the smell based on "foul," "slightly foul," or "neutral" (no rotting scent). Before smelling the compost in the new compost bucket design, subjects waited for a period of five minutes to allow their sinuses and the air in the testing room to clear of any lingering scent. The subjects were asked to return once a day for five days and repeat the same smelling process.

Along with a scent test, a visual test was performed by the experimenter to see if there was any visible fungal or bacterial growth in the sample. The experimenter viewed the samples once per day and determined whether the samples were moldy (over 75% of the sample is rotten), moderately moldy (50-75% of the sample is rotten), slightly moldy (25-50% of the sample is rotten), have little mold (0-25% of the sample is rotten), or if there is no mold (zero visible rot).

We compared data from both the scent and visual test, then performed a statistical analysis to determine if the results from our experiment were statistically significant.

Results

After five days of testing, we focused on the "neutral" ratings from the scent test to perform statistical analysis. The results are as follows:

Table 3:
Number of "neutral" ratings received in the current and new compost bucket designs over the five-day testing period (n=11).

Day	Current Design	New Design
1	5	8
2	4	6
3	3	6
4	6	5
5	1	4

We assumed the data collected from each bucket to be paired data. Using this data, we performed a Shapiro-Wilkes test to determine the normality of the difference between data from the current and new compost bucket designs (W = 0.70079, p – value = .009761). Because the p – value = .009761, the data is not normally distributed and we conducted a Wilcoxon-Signed Rank Test (V = 1, p = value = .09929, α = .1). Because our p-value is less than the alpha, we reject our null hypothesis. There is enough evidence to suggest the new compost bucket smells better than the old compost bucket.

Conclusion

This data provides us enough evidence to pursue further testing. For any following tests, we would like to add additional controls to eliminate any possible confounding variables on this experiment. This includes using a single-blind testing style, new storage location in a lab that limits outside odors, etc. We will extend the tests to a 7-day period rather than a 5-day period to increase the accuracy of the Wilcoxon-Signed Rank Test. Lastly, we will recruit volunteers who know nothing about the experiment to eliminate the possibility of a placebo effect. Hopefully, this will increase the accuracy of our testing and lower the p-value we receive.

Further Testing

Because scent is subjective, we will pursue a quantitative approach by using DNA Sequencing kits to analyze the bacterial growth within the buckets. We recognize smelling-ability differs between each individual, so this testing will provide a sounder way of analyzing the effectiveness of the pyramid shape.

In addition, we will be adding another variable to the experiment. Coffee is known as a scent-absorbing agent (i.e., is used as a palette cleanser when smelling perfume). Therefore, it is a good alternative to baking soda (another scent-absorber) that can be composted when it has reached the end of its use. Additionally, we will be sourcing the grounds from the Starbucks on campus, which will further divert waste from landfills. We have created a new bucket design in the pyramid shape that can hold used coffee grounds (Figure 6). Testing will be like that of the scent testing of this experiment.

Figure 6: New compost bucket design with coffee storage area.

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