

Observing the Meal Preference of Flies (Dipterans) With Strawberries, Spinach, and Ground Beef

Morgan Wilson

Texas A&M University, Department of Entomology

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Abstract: This experiment tests the meal preferences of flies (Dipterans) in the nearby surroundings with fresh and rotten strawberries (*Fragaria x ananassa*), spinach (*Spinacia oleracea*), and ground beef. Each variable was placed onto a plate behind Clements Residence Hall at Texas A&M University and observed for an hour to obtain a sizable amount of data. A total of six sets of trials were run and analyzed through scatter plots and trendlines. The number of flies per variable was averaged and compared to one another. Rotten ground beef, ground beef, and rotten strawberries had the highest fly averages. Of the six total variables tested, Rotten ground beef was shown to be the favored meal of flies. However, the results were biased, as the trials for the strawberries were done under significantly colder conditions than that of the ground beef and spinach. It was determined that the experiment needed modifications to ensure proper analysis and prevent bias. These modifications consist of varying the rotting period of each trial and ensuring that each trial was conducted under similar temperatures, ideally above 20 degrees Celsius. This would allow all observations to be as unbiased as possible while providing more data to analyze and compare, resulting in a very decisive conclusion with little to no error.

Keywords: flies, maggots, diet, decomposition

Flies have been both a pest and a threat for a long time. They are pests because they annoy humans and their animals; incessant buzzing as they fly and pain when they feed function as a stressor (Peter, Van den Bossche, Penzhorn, & Sharp 2005). They are a threat because many flies function as vectors of diseases, parasites, or parasitoids, all of which can cause severe sickness or death (Iqbal, Malik, Sarwar, Azam, Iram, & Rashda 2014). Due to a large number of flies being anautogenous (meaning they require a protein meal, the protein often being blood, to oviposit, also known as to produce or lay eggs), they frequently encounter humans and

their surroundings, increasing the threat that flies pose (Hans, LeBouthillier, & VanLaerhoven 2019; Shymanovich, Hajhashemi & Wasserberg 2020). It isn't easy to prevent them from preying upon humans or their animals, so a different approach was taken.

A person's garbage can contain anything from paper to old toys to broken electronics or food. People put anything inside trash cans. However, if they do not immediately take it out, if food is inside, the flies come. That means maggots and lots of them. This experiment was designed to determine what foods should be sealed prior to putting them

into the trash. One would think to seal everything, but that does not tend to happen. Coming to a definitive conclusion that flies favor one thing over another should spark people to pay attention to what they throw away. The hypothesis for this experiment was that the flies will favor the rotten meat more than the other variables. That would mean people should seal meat before throwing it out if they will not be able to immediately take out the trash to prevent a temporary infestation of flies and maggots, as this can cause something as simple as stress or as severe as death. Presuming people seal the meat they throw out; such a simple action could prevent outbreaks of dangerous sickness and save many lives.

Materials and Methods

Preparation

One pound of strawberries (Driscoll Strawberry Associates, Inc., Watsonville, CA), one pound of spinach (Walmart Inc., Bentonville, AR), and one pound of ground beef (TSD Sales and Distribution, Dakota Dunes, SD) were purchased from Walmart (643 N Harvey Mitchell Pkwy, Bryan, TX 77807). Double Zipper Bags 6 1/2" x 5 7/8" (Walmart Inc., Bentonville, AR) were also purchased from Walmart. Six lipped dark grey plates with a 10 1/2" diameter (Target Corp., Minneapolis, MN) were purchased from Target (2100 Texas Ave S, College Station, TX 77840).

The strawberries were purchased due to studies showing varying flies frequenting the fruit, such as *Drosophila suzukii* and *Zaprionus indianus* (Bernardi, Andreazza, Botton, Baronio, & Nava 2017; Goodhue, Bolda, Farnsworth, Williams, & Zalom

2011). The spinach was purchased because of the Spinach Stem Fly *Hylemyia echinata*, Mangold Fly *Pegomyia betae*, and Bean Seed Fly *Delia cilicrura* (Miles 1953). The ground beef was purchased because the number of anautogenous flies is particularly numerous, and beef was the most affordable option. The double zipper bags (from here on, known as "zip locks") were purchased to separate the variables from the environment; this would prevent other organisms from affecting the experiment by accelerating or modifying the decomposition of each variable, respectively. Enclosing each variable would slow down its decomposition time and keep it controlled. The plates are to empty the contents of the bag onto, large enough for the contents to spread out but small enough to be easily observed.

After purchase, all variables were opened and placed into the zip locks, then sealed. Air was not removed from the bag prior to sealing. The initial zip lock was again put into another zip lock to ensure complete isolation. They were then left in a shaded area to avoid inconsistent exposure to sunlight until they were determined to be satisfactorily decomposed. The beef, which filled the bag the most compared to the other two variables, took approximately six days to reach a satisfactory decomposed state. The spinach took approximately four days. The strawberries only took three days. After each respective variable was significantly decomposed, a fresh one was purchased.

Observing Fly Preference

In order of the time it took to complete decomposition, the layout and observation process began behind Clements Residence

Hall (211 Jones Street, College Station, TX 77840), a quiet, unfrequented, grassy area. It was chosen to avoid excessive noises or interaction between the variables and any flies. The only interaction with the variables was the environment (temperature, sunlight, air, etc.), the observer, and any potential flies. All trials were performed at the same time of day, late morning.

After walking to the location with the bag of rotten strawberries, the container of fresh ones, and two plates, the bagged strawberries were dumped out of the bag and onto the plate. The fresh strawberries were removed from their container and placed on the other plate. The two plates were placed five feet apart, and the observer sat five feet away from them, central to both samples. This allows the observer to see any flies that land on the samples without disturbing them. The samples were left to acclimate in the environment for 10 minutes using the timer on the default Clock app of an iPhone 12 mini (Apple Inc., 1 Infinite Loop, Cupertino, CA).

Once acclimation was complete, a 10-minute timer was set. After the timer sounds, it was

Results

In this portion, the terms “spoiled” and “rotten” will be interchangeable to refer to the decomposed variables. The results from the experiment were in favor of the rotten variables, shown by their significantly increased averages (Table 1). Flies favor decaying material, so this was expected.

set to repeat. The number of flies on each sample was noted, and the process was repeated until six 10-minute trials were achieved. The plates were then tapped repetitively to remove the flies from them, then disposed of. This process was then conducted for the spinach, then the ground beef. The number of flies for each variable was then averaged.

Analysis

A cumulative table was created (Table 1). Five scatter plot graphs were created: the number of flies on strawberries and spoiled strawberries per trial (Fig. 1), the number of flies on spinach and spoiled spinach per trial (Fig. 2), and the number of flies on ground beef and spoiled ground beef per trial (Fig. 3). A trendline, equation for the line, and R^2 correlation values were included. Then one additional graph was created: the number of flies on each spoiled sample per trial (Fig. 4). A trendline, equation for the line, and R^2 correlation values were included. The variable with the most significant number of files was determined and compared to the hypothesis to determine fly meal preference.

However, it is believed that the experiment (conducted in mid to late November) was moderately affected by the unexpected cooler temperatures. This is shown by the low number of flies frequenting the rotten strawberries, which, under normal circumstances, would have likely been more frequented by fruit flies.

Table 1. No. of Flies on Each Variable per Trial

Trial	Strawberries	Spoiled strawberries	Spinach	Spoiled spinach	Ground beef	Spoiled ground beef
1	0	1	0	0	1	21
2	0	2	0	1	3	16
3	0	1	0	1	2	23
4	0	1	0	0	1	18
5	1	2	0	0	1	17
6	1	3	0	1	2	18
Avg #	0.33	1.67	0	0.50	1.67	18.33
Rank	5th	2nd	6th	4th	2nd	1st

The sample of spoiled ground beef came in first by having an 18.33 average number of flies per trial, with a maximum of 23 and a minimum of 16. The fresh ground beef and

spoiled strawberries tied for second with an average of 1.67 flies per trial, with a maximum of 3 and a minimum of 1 for both variables (Table 1; Figs. 1 and 3).

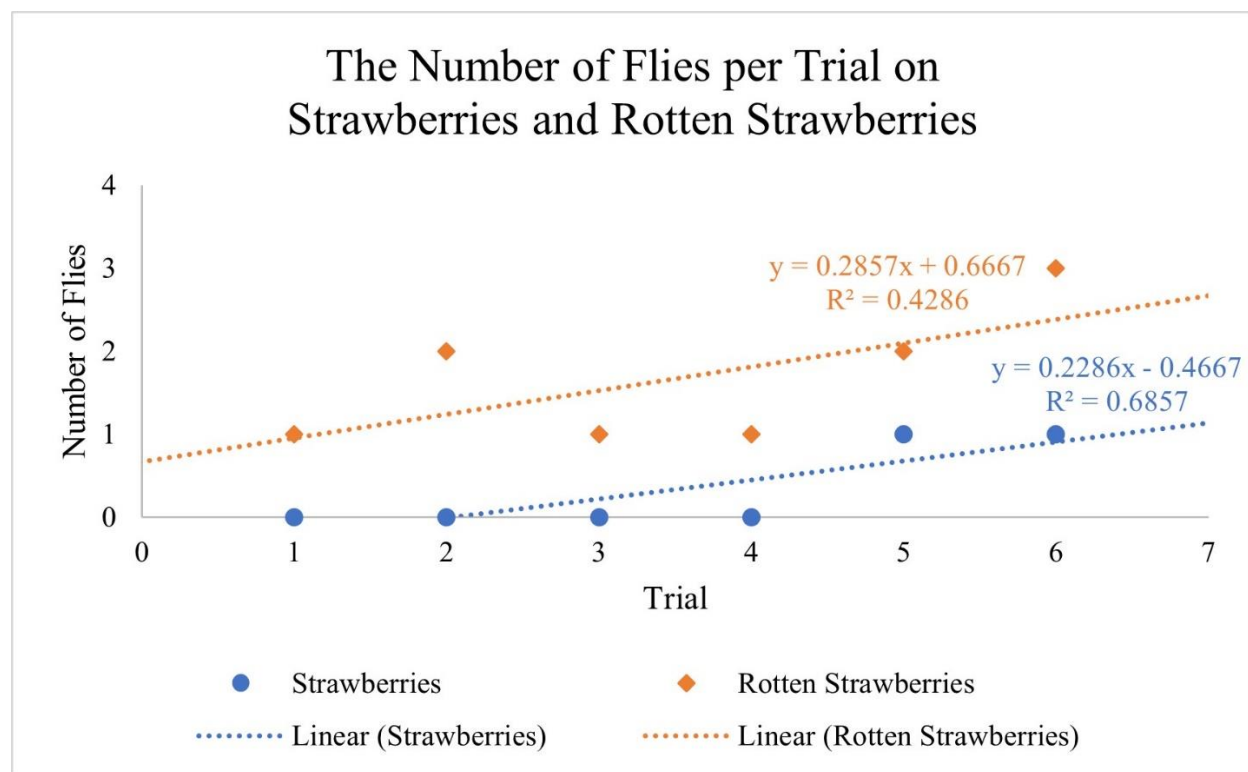


Fig. 1. The relationship between fresh and rotten strawberries with the number of flies that frequent each.

However, the spinach trials were underwhelming, with the fresh and rotten

spinach coming in 6th and 4th, respectively (Table 1; Fig. 2).

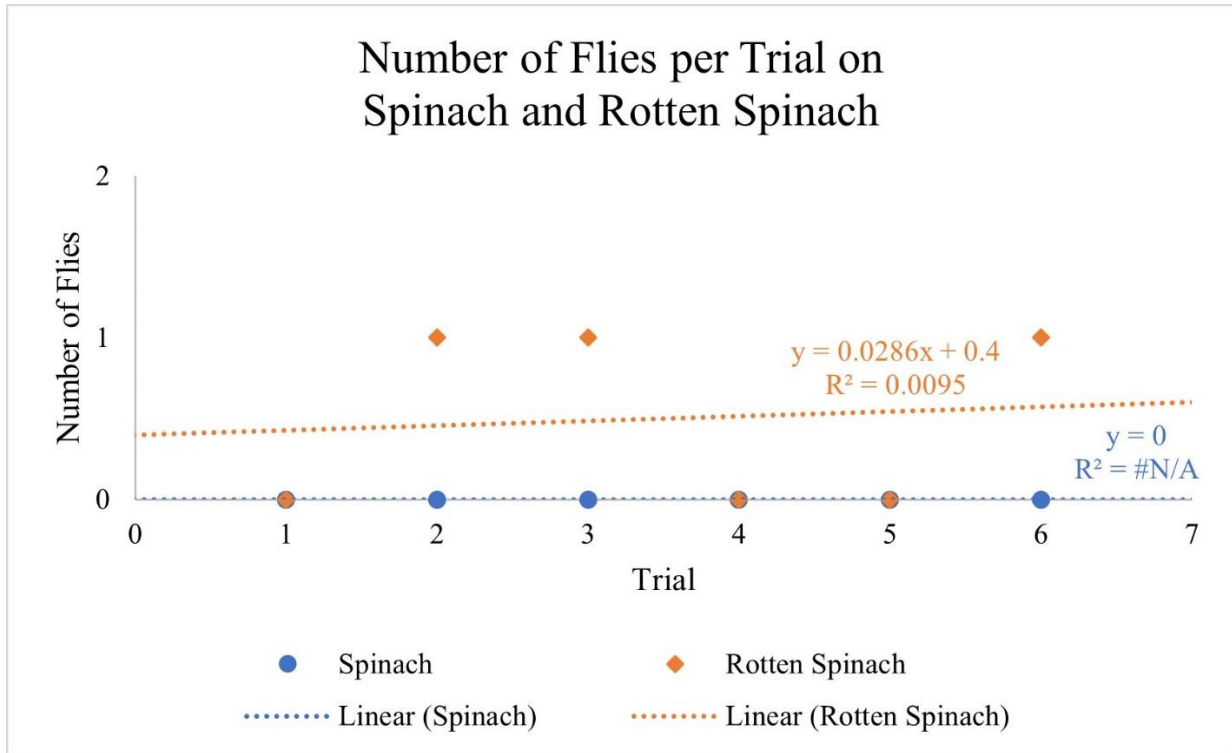


Fig. 2. The relationship between fresh and rotten spinach with the number of flies that frequent each.

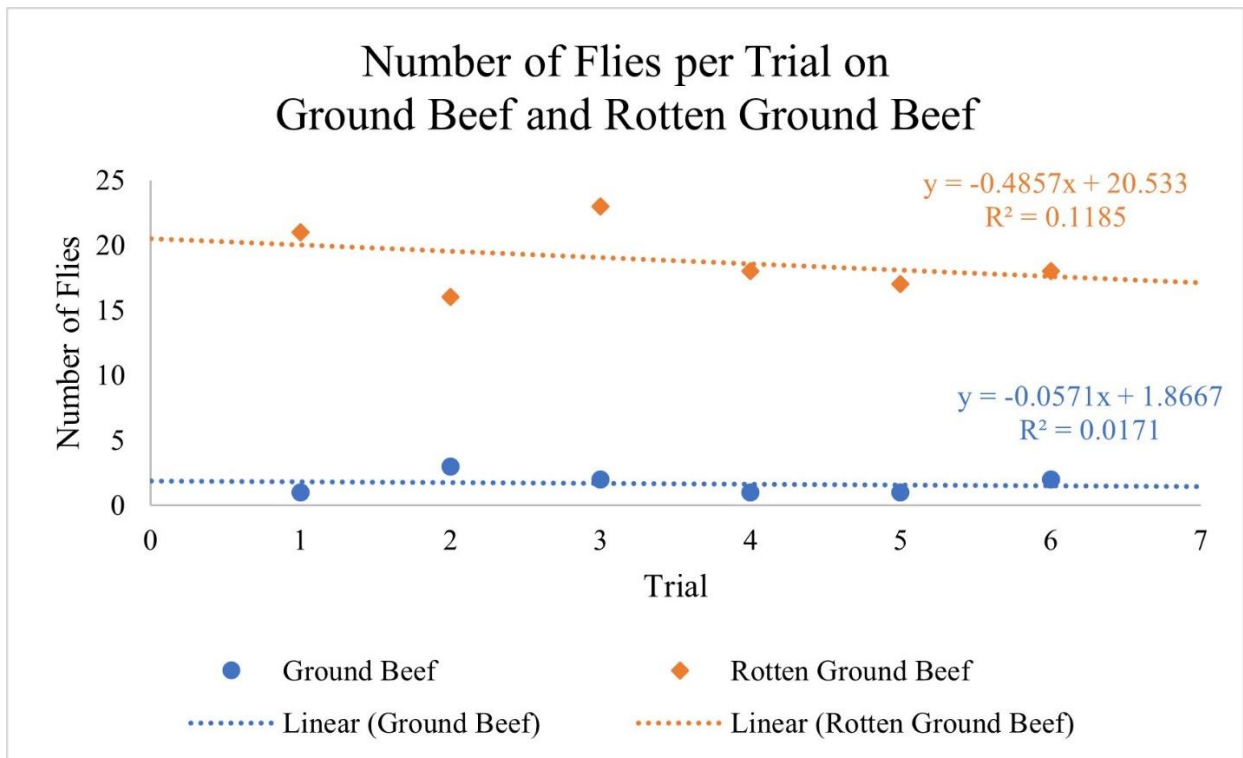


Fig. 3. The relationship between fresh and rotten ground beef with the number of flies that frequent each.

The variables with the largest average were made into a graph to show the vast differences between fly meal preferences (Fig. 4). As said earlier on, due to a large number of flies being anautogenous, the variable with the most significant number of

flies on it at any given time was the rotten ground beef. A large amount of blood spilled from the ground beef during the decomposition process is significant, providing easy-access protein meals to allow females to get ready to oviposit.

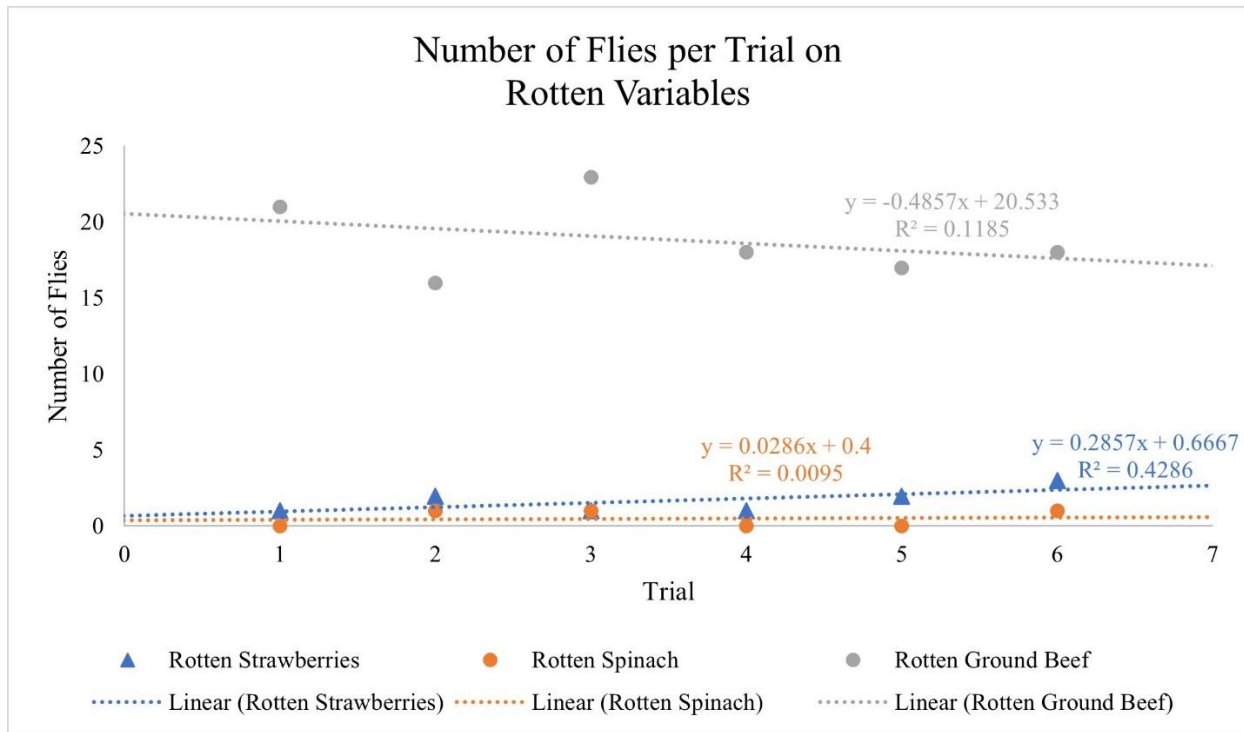


Fig. 4. The relationship between fresh and rotten strawberries, spinach, and ground beef with the number of flies that frequent each.

Discussion

The experiment results were conclusive and matched with what was expected due to the large number of flies that frequented the rotten ground beef. However, despite the clear results, the experiment can be viewed as biased towards the ground beef, as that set of trials was performed under the intended temperature. In contrast, the strawberries experienced a significantly colder observational setting (Guédot, Avanesyan, & Hietala-Henschell 2018). The strawberries

would most likely have had a more significant number of flies per trial had it been performed under the same temperature and general humidity as the beef and spinach, as females are less likely to seek meals for oviposition in non-ideal conditions (Hans *et al.* 2019). According to Taylor, Moon, and Mark (2012), flies are a frequent and particularly damaging pest of cattle, so the rotten ground beef can reasonably be assumed to accumulate the most significant number of flies regardless of the moderate inconsistencies of environmental factors

(initially it was thought that rain was the only real ecological factor that needed to be avoided. However, this expectation was proven incorrect, shown by the unexpected strawberry results). If this experiment were ever to be conducted again, it would be ideal if each set of trials were performed under the same general conditions, meaning approximately the same temperature (20 to 25 degrees Celsius), humidity, and time of day (Hans *et al.* 2019).

Additional adjustments to improve the experiment would be a more significant

number of trials under differing conditions, such as multiple different set number of days for each variable to decompose (3 days, five days, seven days, etc.), to see if the level of decomposition will affect how many flies are drawn towards each variable.

As the number of flies on the rotten ground beef was far above the other variables, people should seal any meat they will be disposing of into the trash can to prevent a temporary infestation of flies and/or maggots.

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