

The Attractiveness of Various Household Baits to *Drosophila melanogaster* (Meigen) (Diptera: Drosophilidae)

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Abstract

While *Drosophila melanogaster* (Meigen) (Diptera: Drosophilidae) has been well studied for its scientific uses as a model organism, not as much work has been put into controlling them as pests across the world. These fruit flies are a common nuisance to households everywhere, and can present health issues through spreading bacteria and other pathogens it comes into contact with onto the food we consume. Controlling them is largely done with baited traps which they are attracted to, but finding what substances they are most attracted to can improve the effectiveness of these traps. For this experiment, seven household substances including, apple cider vinegar, 20% sugar water, simple syrup, banana slices, mushroom slices, beer, and wine, were used to bait traps. These were all placed outside, to compare and test their attractiveness to *D. melanogaster*. It was found that after eight days out, bananas attracted the most flies, followed by mushrooms, apple cider vinegar, wine, beer, simple syrup, and then the 20% sugar solution. The results were mostly consistent with what was expected considering what compounds fruit flies are attracted to. The results were able to demonstrate what household items prove most effective in attracting fruit flies in order to remove the pests from wherever it is needed. Additional research could look into the attractiveness of each of the active chemicals fruit flies are attracted to, and also find what concentrations and mixtures of these are most attractive to better make a bait for the flies.

Keywords: fruit-flies, pests, bait, attractiveness

Drosophila melanogaster (Meigen) (Diptera: Drosophilidae) is well studied for its application in research sciences, especially genetics. Also known as the common fruit fly, it has made a name for itself in the everyday lives of many people, but as a pest. When the flies are left with plentiful amounts of food, they can quickly proliferate and in the worst cases form clouds of flies across whole neighborhoods (Ubelacker 2009). Even though this is typically not the case, even just a few flies in a home with rotting produce or other wet

places to reproduce in can prove incredibly annoying, and also spread infectious bacteria or pathogens onto food. The most cost-effective way to treat this pest issue is by setting up baited traps which draw the fruit flies in, and then can leave them there to either drown, starve, or die from poisoning if that is added to the bait.

There are various different baits that have proved effective on attracting fruit flies, including apple cider vinegar, and fermenting baits (Burrack 2015). Their natural food source is rotting fruit or vegetables which can

harbor their brood. The flies find this by picking up on the odors and chemicals emitted by these rotting fruits, such as acetic acid and ethanol. Apple cider vinegar is acetic acid, so it imitates this natural chemical that the flies pick up on. A similar situation arises with wine and fermented goods, which contain ethanol and release that into the air. Additionally, fruit flies, like most all animals, are attracted to sugar, as it is the basic nutritive source of energy (Freeman 2015). These are all common household items which can be effectively rigged in a trap to attract fruit flies and remove them.

In this study, many variations of these imitation baits were tested for their attractiveness to fruit flies. Two solid baits, one of bananas and the other mushrooms, were also used to compare how these imitation baits worked compared to what the natural food of the fruit fly would do.

Materials and Methods

Traps A total of seven traps were constructed for the experiment. Each one consisted of a 5oz foam bowl (Genpak, Carthage, Texas), where the bait was then placed, and then a transparent plastic wrap (Great Value, College Station, Texas) which was wrapped around the top to cover the open end of the bowl. Then seven small holes, the size of pinhead, were poked into the stretched plastic wrap cover, in order to allow the volatile odors out of the bait and into the air, and also to let the flies follow that odor and crawl through the holes. The idea is that the flies could follow the odor in, but then have such small exits, and no real way of knowing where they are, that they aren't able to leave.

Baits Seven baits were prepared to go along with the traps. For the 20% sugar water, a tenth of a cup of sugar (Imperial, Sugar Land,

Texas) was added to four-tenths of a cup of water, and mixed until all sugar was dissolved. The simple syrup was made with a quarter cup of sugar and a quarter cup of water, to make half a cup of the syrup, which was added to the trap. Half of a cup of Apple cider vinegar (Heinz, Pittsburgh, PA) was used as a bait. Half of a cup of Miller High Life beer (Milwaukee, WI) was used for the beer bait. Half of a cup of merlot (Yellow Tail, Yenda, Australia) was used as the wine bait. The bananas were prepared by peeling the banana and then slicing it into centimeter thick clices, and then six slices were placed on the bottom of the trap. For the mushrooms, six slices of portabella mushrooms (HEB Organics, San Antonio, TX) were placed in the bottom of the trap. The solid baits were just the bait, but for each liquid bait, approximately three drops of dish soap (Dawn, Cincinnati, OH) were added and mixed into the bait. This lowers the surface tension of each bait, and essentially causes the flies to get stuck and drown in whatever liquid bait they land onto.

Bait Trap Locations All the traps were placed in a yard in the Bee Creek area of College Station, TX. They were placed on a raised surface to all be around four feet high, and each trap was separated by ten feet between the next trap to ensure they had enough space and their odors would not interfere with each other.

Data Gathering The traps were all placed in their location at approximately 6 p.m. central time for a total of eight days, and were checked on for data gathering every two days at approximately the same time, a total of four times each. Each time the traps were checked, the number of *D. melanogaster* present in the trap (underneath plastic wrap) was recorded. The plastic wrap was never

removed for each period, and the flies left in each trap.

Results

A comparison of all the materials tested revealed a large variation in the number of flies at each bait at different times (Table 1). The apple cider vinegar trap collected nine flies by day two, 13 by day four, 20 by day 6, and 23 by day eight, and averaged 5.75 flies every two days when the traps were checked. The greatest increase between periods was nine flies from the start to day two, where 39% of the total flies were trapped. The 20% sugar water was seen with no flies on day two, a single fly on day four and six, and finally one more fly between days six and eight, showing relatively consistent growth given the small sample size. The simple syrup trap had one fly on day

two and four, three flies on day six, and six flies by day eight, showing an increase of half of its total from day six to eight. The banana slices had five flies by day two, 12 on day four, 23 on day six, and 36 by day eight. This showed an increase in the number of new flies with each period, collecting 36% of its total flies between day six and eight. The mushrooms were similar to the bananas in that they also had the number of new flies grow with each period, beginning with zero flies on day two, four flies on day four, 14 on day six, and jumping all the way to 26 by day eight, giving a 46% increase in the last period observed. The beer bait trap collected two flies on day two, had three by day four, six by day six, and eight by day eight. This showed a more consistent increase over the whole experiment. The wine trap had three flies at day two, five at day four, seven at day six, and jumped to thirteen at day eight. This jump observed in the last period was 46% of its total flies.

Table 1. Comparison of Baits by Number of Collected Fruit Flies

Bait	Number of Flies Present				Average Rate of Flies at Traps per 2 Days
	Day 2	Day 4	Day 6	Day 8	
Apple Cider Vinegar	9	13	20	23	5.75
20% Sugar Water	0	1	1	2	0.5
Simple Syrup	1	1	3	6	1.5
Banana	5	12	23	36	9
Mushroom	0	4	14	26	6.5
Beer	2	3	6	8	2
Wine	3	5	7	13	2.6

The rates of new fly captures can be calculated between each period to see between what periods each trap was collecting the most or least amount of flies (Fig. 1). The rate of change of flies shows how many new flies are being observed in each bait trap over the course of the experiment. The sugar water experienced the lowest rate of change, with only one new fly observed over any of its periods. Both beer and simple syrup experienced the lowest rate of change, with only one new fly observed over any of its periods. Both beer and simple syrup experienced the lowest rate of change, with only one new fly observed over any of its periods. Both beer and simple syrup experienced the lowest rate of change, with only one new fly observed over any of its periods. Both beer and simple syrup experienced the lowest rate of change, with only one new fly observed over any of its periods.

days four and six) and the simple syrup at period four. Next was the wine, which experienced an increase of six flies in period four, and only two or three flies in the previous periods. The apple cider vinegar was observed to have a very high rate of change off the start in period one, with nine new flies, but dropped thereafter. Both the mushroom and banana baits were observed with the highest rates of change, with the banana peaking at 13 in period four and mushroom at 12 in period four. Both of these baits began with relatively low rates of change, and grew over each period.

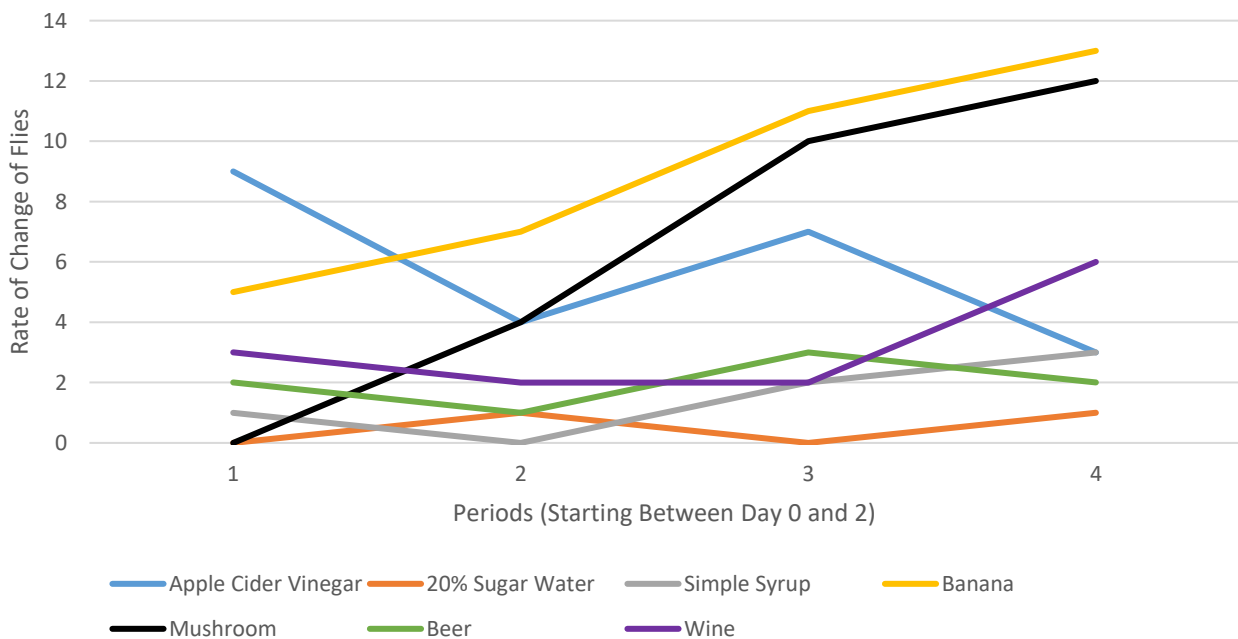


Fig. 1. Graph of the Rate of Change of Flies in Different Bait Traps over Time

Discussion

Fruit flies are well known to be common household pests, specifically the common fruit fly, *drosophila melanogaster*. Their ability to lay about 500 eggs in a two week life span gives them the potential to go

from a small nuisance to a major home infestation in a very short amount of time (Ubelacker 2009). Trapping adults with trap and lure combinations is a cost-effective approach to removing the pests, and stopping the population from growing (Lasa R., et al. 2017). Understanding what attractant is most

effective at drawing in the flies is important to ensure the trap can capture as many flies as possible. It has been previously seen that *drosophila suzukii* (Diptera: Drosophilidae), a species closely related to *drosophila melanogaster*, was highly attracted to fermented bait traps, which used a mixture of yeast, sugar, water, and apple cider vinegar (Burrack 2015). The results from this experiment demonstrated that fruit flies were initially attracted to the apple cider vinegar more than any other bait used. They are known to be attracted to fermented sweet materials, and the volatile chemicals along with those, such as acetic acid and ethanol (Cha 2012). However, the number of fruit flies attracted to this bait at each period decreased after the first period. An explanation as for why this occurred could be because the bait was outclassed by the other ones on the later periods, and therefore less flies chose this bait.

Both the 20% dilute sugar water, and the simple syrup proved to be far less effective than the other baits at attracting the fruit flies. Neither of these baits put out any chemicals odors that are characteristic of fermentation or rotting fruit. The only attractive aspect of these baits was sugar, which the flies could use for energy, but not what they are known to be highly attracted to. This explains why each of those baits acquired far less flies than any of the others. The beer bait also ranked relatively low when compared to others. This is to be expected, as the beer is much more dilute than wine, and probably produces far less attractive chemicals for the fruit flies to pick up on. The wine had several more flies than the beer, and was quite attractive to the flies due to its alcohol content and release of attractive chemicals to the flies.

The two solid baits used both had related results, but were quite different than any of the other baits. When analyzing how many more flies were there each period, these baits began increasing far more than the others. The banana began attracting more flies sooner than the mushrooms, likely because it began to rot first. The reason for the constant growth of fly numbers in both of these baits is that they began to rot more and more, releasing more of the characteristic chemicals that the fruit flies are looking for. Each of these baits was put out when they were fresh, providing an explanation as to why they had so many fewer flies in the first and second periods than the third and fourth.

One issue with the solid baits was that the flies did not become stuck in a liquid bait as they would with the other traps, and could go about their lives in the trap. However, the plastic wrap was covering the top, and the small holes in the wrap would be very hard to distinguish and escape from for the flies. Another possible concern for the solid baits and how they did not kill the fly was that the flies could reproduce in the bait and therefore add to the recorded number, even though the offspring were not actually attracted to the bait. However, this is not a concern when the typical life cycle of *D. melanogaster* is taken into account. Their typical life cycle from egg to adult takes 14 days, and even under heat stress, which accelerates the cycle, the process still takes 11 days to complete (Podder 2015). This is longer than the period of the experiment which was only eight days total, meaning the number of flies in the solid baits could not have been overrepresented from reproduction.

All of the traps managed to attract some number of fruit flies, but finding the most attractive household bait was the

purpose of the experiment. It is clear that the actual rotting bananas and mushrooms were more attractive than any bait that imitates the chemicals these put out. Even so, when trying to bait fruit flies as pests, it would be ideal to kill the flies along with attracting them, and also not give them just more areas to breed on, as this could make the issue even worse.

When that is considered, it might be worth sacrificing some attractiveness of the bait to use something like apple cider vinegar or wine that could actually collect and drown the flies to remove the pest issue.

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