Survey of Household Methods that can lessen the *Ctenocephalides felis* (Pulicidae: Siphonaptera)(Bouche) population

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Abstract Fleas are arthropod ectoparasites dependent on a bloodmeal from a vertebrate host at each developmental stage for the completion of their life cycle. Flea feeding cycles impact animal's health by causing damage to hides, secondary infections, immune reactions, and diseases caused by transmission of pathogens. The species *Ctenocephalides felis (C. felis)* (Pulicidae:Siphonaptera)(Bouche) is the most commonly found flea in the household, due to the fleas favoring dogs and cats for blood meals. These domesticated pets attraction of fleas could lead to an infestation in the house, where humans can serve as hosts unless there is an exterminator intervention. Exterminators can be costly for the average household. A survey was conducted to determine if more household methods could be used to eradicate the fleas. Four flea infested rooms were treated for six days with either water, lemon water spray,Diatomaceous Earth or Dawn dish soap. There was up to 25 fleas eliminated in the dawn and water mixture in room D. Dawn's' ability to deteriorate the fleas exoskeleton, makes it a highly affordable household item that has the potential to replace costly exterminators.

Keywords: flea, dog, cat, insecticide, household methods, *Ctenocephalides felis*

Fleas are one of the most common household pests. Fleas thrive on any warm vertebrate such as: cats, dogs, and even humans. The problem with fleas is the egg's ability to lay dormant for long periods of time. The most common domesticated flea in the United States is *C. felis*. There have been around 2,500 flea species described and at least 15 of these infest dogs and cats (Coles & Dryden, 2014). Despite the cat flea being a pest it is also known to cause Flea Allergy Dermatitis (FAD), in dogs, cats, and sometimes humans. Although this is the most common effect of the *C. felis,* this species also vectors the Dog Tapeworm (*Dipylidium caninum)* and although rare, the plague and murine typhus. Fleas found on pets are typically only ten percent of all of the fleas in the vicinity. The eggs, larvae, and pupae are residing in the living areas of the pet. Although it is crucial to eliminate the fleas on pets, it is just as important to eliminate these pests from taking over one's household. An estimated $348 million is spent annually for professional flea control (Lemke, 1989). These control methods consist of harmful chemicals being sprayed all over the home.The drastic prices of eradicating fleas and anti-chemical movements has caused many to seek household items as sources of exterminating the fleas. Diatomaceous Earth has effectively removed flea populations from tree nest (Dawson 2003). Another common flea removal item consists of the use of citrus peels (Jesiolowski and Van Dusen 1992). Dawn dish soap is often associated with its ability to clean oil off aquatic animals, it also has been known as an insect

repellent (SFGate). Little research has been conducted comparing these three common household items, which is why this experiment was done. This research has the potential to provide the public with cheaper methods of flea removal and, also opens the door for more comparative analysis of other household items effects on fleas.

Materials and Methods:

Three different household methods for flea control were tested in regard to the *C. felis*. These were tested on November 26th to December 2, 2015 as well as February 3rd to February 9, 2016. The experiment took place in an apartment in College Station, Texas with four bedrooms, all with concrete floors. No pets were allowed in the apartment during the research. Room A was kept as the control. Room B was tested with Diatomaceous Earth. Room C was tested with Lemon Water Spray. Room D was tested with Dawn Soap and a desk lamp. Each flea control method was tested every two days for six days. The rooms were all vacuumed and the baseboard were wiped down prior to the flea control methods.

Room B was tested using Diatomaceous earth food grade in a spray bottle. Diatomaceous earth food grade was sprayed throughout the area of the room coating the floor with a thin layer.

Room C was tested with lemon water spray. Three lemons were cut thinly and put into a pot to boil with one pint of water. After the water started to boil, it was then kept covered in the pot overnight to steep. The lemons were removed from the pot and the liquid mixture was then poured into a new spray bottle. The area of Room C was sprayed with this mixture and left to dry.

Room D was tested with Dawn Soap and a light source whose bulb hung over the 5-quart storage container, which had a mixture of two cups of water and one cup of Dawn Blue Dish Soap. All of the lights were turned off and the blinds were closed. The lamp was left on for 24 hours and then the container was checked. After two days of letting the flea control work, the dead fleas in the area were accumulated using a handheld vacuum cleaner that was then sorted through. The dead fleas that were removed from Room D, were collected and counted. A comparison of means test was used to identify the differences between treatments.

Results:

As recognized, all of the methods were somewhat effective. Many do it yourself websites recognize Diatomaceous Earth as one of the most cost effective and successful methods. It is a powder that is the remains of a fossilized type of algae called diatoms. The diatoms' cell wall contains silica which is a major component in glass. Fleas with an exoskeleton are susceptible to the glass sharp edges of the microscopic diatoms. When used in Room B, the mean of fleas killed and collected was four fleas for round one of the experiment. In February, when this method was used again a total of 10 fleas were collected.

Another common household flea control was using lemon water spray. In the first round of household extermination, the mean of fleas killed and collected over the span of six days in Room C was four fleas. It was noticed that there were many live fleas in Room C while the dead specimens were

collected. Figure one shows the collected fleas from Room C on day six. During the second round of the testing, the highest number of fleas collected from one day was five.

Figure 1. Collected Fleas from Room C on Day Two (Round Two)

The Blue Dawn Dish soap and the lamp in room D was known to attract the fleas with the source of heat and then have them fall into the tub of dawn soap and water where the Dawn Soap would break down the exoskeleton of the flea therefore killing it. In the first round of the experiment the mean of the collected fleas from room D was approximately 12. In the second round of the experiment, the highest number of fleas collected was nine. In part one of the experiment, there is a distinct linear increase in the number of fleas collected as the days went on in Room D. Figure two below shows the fleas collected on day four after the water and Dawn mixture had dried up.

Figure 2. Collected Fleas from Room D on Day Four (Round One)

The figures below (figure three and four) juxtapose the effectivity of the household flea controls. It is evident that the Room B and Room C had very similar effects on eradicating the fleas.

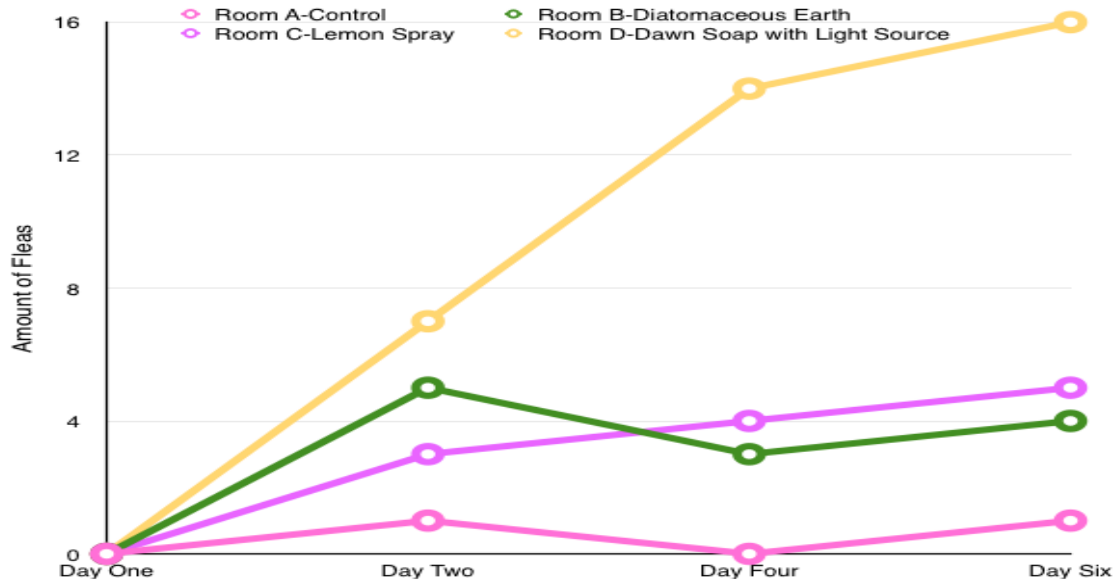

Figure 3. Graph of Fleas Collected Depending on the Household Products for Round One of the extermination methods (November-December 2015)

	Day One	Day Two	Day Four	Day Six
Room A-Control	0	1	0	1
Room B-Diatomaceous Earth	0	5	3	4
Room C-Lemon Spray	0	3	4	5
Room D-Dawn Soap with Light Source	0	7	14	16

Figure 4. A Chart Showing Accumulation of All Data from Collecting Fleas for Round One of the extermination methods (November-December 2015)

	DAY ONE	DAY TWO	DAY FOUR	DAY SIX
ROOM A- Control	0	0	0	1
ROOM B- Diatomaceous Earth	0	4	4	2
ROOM C- Lemon Spray	0	5	3	2
ROOM D- Dawn Soap	0	8	7	9

Figure 5. A Chart Showing Accumulation of All Data from Collecting Fleas for Round Two of the extermination methods (February 2016)

Discussion/Conclusion:

The most effective household method was with Room D which consisted of using Dawn soap with a light source. After six days of testing there were a total of 16 dead fleas using this method for round one and 9 for round two. The other three methods produced about the same result with the lemon spray method and Diatomaceous Earth having 12 dead fleas each for round one and 10 each for round two. The Diatomaceous Earth might not have been as successful as it could have been due to the moisture in the air with the heater being on. The lemon spray may repel fleas, however it was not successful in controlling and killing the fleas. In the control room, there was only one dead flea which most likely died due to natural causes. Fleas are attracted to heat so having the lights off in Room D with the heat lamp attracted most of the fleas. The Dawn Soap destroys the flea's exoskeleton and kills them very quickly. Dead fleas collected does not necessarily give an overall effectiveness of the household products. The vacuum could have missed some fleas despite the thorough vacuuming. There could also be some dead fleas in the baseboards that could not be accounted for.

If the experiment was longer than six days, the results might differ. Some of these household items might take more than six days of being repeated to become as successful as they are meant to be. A source of error could be that Room D could have been more flea infested than the other rooms due to that being the place where a bunny usually resides. This could make the data from Room D skewed. An idea for future research experiments is to test the heat from the light source along with other household products. This will determine whether it was the Dawn Soap that worked most effective or the heat from the light source that made it seem most effective.

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