The Effectiveness of Antibacterial Dish Detergent and Non-antibacterial Dish Detergent when Used on Kitchen Sponges

Lakita Burr, Saint Martin's University, 5300 Pacific Avenue SE, Lacey WA 98503. This work was supported by Saint Martin's University.

Abstract

In this study, the effectiveness of antibacterial dish detergent vs. non-antibacterial dish detergent on kitchen sponges was investigated. The sponges were used daily for normal kitchen uses for one week. Three sets of sponges were sampled over three weeks. Ten participants used antibacterial dish detergent for one week, while the other ten used non-antibacterial dish detergent for one week. After each sponge was used for one week, it was collected and a new sponge was given to the same participant. Sponges were placed in a bowl of distilled water for 5 minutes, water was squeezed out of the sponges into a dish and then the liquid from the sponges was transferred into a 3 ml cuvette, which contained nutrient broth. Samples were run through a spectrophotometer to measure their transmittance and then using the formula O.D. = log (100%/T), their optical densities were calculated. A two sample t-test was run to compare the two detergents. For all three weeks of the experiment, daily use of antibacterial dish detergent had no effect on reducing bacteria growth on kitchen sponges ($p>0.05$) compared to non-antibacterial detergent.

Introduction

There are many ways that bacteria can grow and cross-contaminate things throughout homes. One of the main causes of bacterial growth in kitchens is kitchen sponges and dishcloths. Kitchen sponges and dishcloths are one of the most contaminated environments in the home, as they retain moisture and offer a favorable environment for bacterial growth once contaminated (Nielsen, 2002). Many people may not be aware of how much bacteria one sponge can carry, and they may not know that food poisoning is a common occurrence in the United States with 5.5-6.5 million cases reported per year (Nielsen, 2002). Food poisoning is often a result of cross-contamination in the kitchen. The five most common types of bacteria found on kitchen sponges and dishcloths are the following: *aerobic mesophilic*, which are non-pathogenic microbes that are found in human or animal waste that indicates the presents of water pollution; coliform, which are bacteria that live and grow where free oxygen is present; *Escherichia coli; Pseudomonas aeruginosa* and; *Staphylococcus*. In order for these bacteria to live, they need air, oxygen and food. In the experiment I propose, I will test the use of anti-bacterial dish liquid soaps on sponges and the effects they have on the growth of bacteria and cross-contamination in the kitchen.

Nielsen (2002) did a study on the use of liquid dishwashing compounds to control bacteria in kitchen sponges. In the experiment, the new sponges had to be cleaned in order to remove excess preservatives and chemicals that come in sponges. The study consisted of commercial products advertised in the United States (antibacterial hand soap), United Kingdom (antibacterial sponge), Japan (antibacterial sponges), and world wide (antibacterial sponges). Nielsen found that some antibacterial soaps and sponges can be very effective, while others are not as effective. The experiment demonstrated that not all the products are 100% effective at reducing bacterial growth. The commercial product in the United States caused only a 33.9% reduction in microbial growth. Japan's commercial product only showed a 45.1% reduction and the commercial product in the United Kingdom showed an increase in the growth of microorganisms within the sponge.

Ojima (2002) studied the bacterial contamination of Japanese households and related concerns about sanitation. In his study, he tested bacterial growth from five Tokyo homes, which each had children who were younger than school age. The reason he selected these homes was because he believed that homes with very young children demonstrated relatively high concerns about illness and hygiene (Ojima, 2002). The samples were taken using the agar sampling method and were based on the movement of children and the location of objects. The movements and objects included entryways, kitchens, floors, sinks, dining areas, and bathrooms. The experiment consisted of 90 sample sites throughout the homes that Ojima believed were at a high risk of cross-contamination. To reduce bias, the subject households were asked to do nothing outside of their normal practices to clean their homes before samples were taken (Ojima, 2002).

After completing this study, Ojima found aerobic mesophilic bacteria and coliform counts to be the highest in the kitchen, followed by bathrooms (Ojima, 2002). The reason aerobic mesophilic bacteria are high in the kitchen areas is due to countertops, cutting boards, and refrigerator doors that are washed with the same sponge or dishcloth after preparing raw meat. When this is done, it allows bacteria to grow on the surfaces because all bacteria need is oxygen, food, and a temperature of (50-115 ^{o}F) to stay alive. In kitchen refrigerators, a group of species called *coliforms* were found in vegetable compartments due to the amount of moisture that vegetables cause. Mold tends to grow, causing bacteria such as *E. coli, P.aeruginosa and Staphylococcus aureus* to grow wherever there is water that is not completely dried up. Some examples include bathroom floors, kitchen counters, and sinks. Bathrooms had the second highest bacteria count due to the amount of water and moisture/steam left behind after the taking of baths or showers. The study also found that bacteria counts for toilets were the same as or lower than those for rooms with sinks and about the same as those for dining/living areas (Ojima, 2002).

Bacteria are found everywhere, from kitchen countertops to door knobs to hands and to eating utensils. Bacteria such as *E. coil, S. aureus* and *Salmonella* survive on hands, sponges/cloths, utensils, and currency for hours or days after initial contact with microorganisms (Erdogrul and Erbilir, 2003). Erdogurl and Erbilir tested the microorganisms in kitchen sponges by evaluating the growth conditions of bacteria, liquid held in sponges that cause bacteria, and the effect that dishwashing liquid has when using sponges. In order to conduct the experiment, each sponge that was used was washed in hot water to remove traces of preservatives and other chemicals that might cause an antibacterial effect. The reason this was done was because when one buys sponges from the store, they already come with preservatives in the sponges in order to keep bacteria from forming. One thing that many people do not know is that the preservatives die off after continual use. Once the washing was done, the sponges were put in cold tap water for sixty seconds and squeezed to remove excess liquid. The sponges were then boiled in sterile distilled water for ten minutes, excess water was once again removed, and the sponges were placed in an oven overnight to dry (Erdogrul and Erbilir, 2003).

The sponges were used in different houses and evaluated for mesophilic aerobic bacteria, *Staphylococci, Pseudomonaus, Salmonella,* coliforms, yeast and mold. The bacteria were activated in 10 milliliters of brain heart infusion broth suspension followed by incubation for 20-24 hours at 37^o Celsius for *E. coli and S. typhimurium* (Erdogrul and Erbilir, 2003). When determining the effect of dishwashing liquid in sponges, dishwashing liquid was added to sponges in the amount of 3 % (+/- 1.5%) and sponges were diluted in 0.85% of NaCl to a final concentration of about 10^6 colony forming units (bacteria) per milliliter. Ten sponges were contaminated with 10 milliliters of test suspension of *E. coli* and *S .typhimurim,* and then 10% milk was added to the sponges in order to soil the conditions. Finally, all the sponges were stored at room temperature (Erdogrul and Erbilir, 2003). The results indicated the use of dishwashing liquid daily had no effect on fungal growth, *Pseudomonas* growth or *E. coli* growth, but the number of *Salmonella* decreased. Sites such as kitchen sinks and toilets are most commonly associated with heavy contamination and the occurrence of potentially harmful species. Other wet sites such as dishcloths and sponges were found to have heavy contamination (Erdogrul and Erbilir, 2003). Areas where raw meat is prepared and not cleaned properly have a high chance of cross-contamination throughout the house. Stainless steel, due to its resistance to abrasion and impact damage, is more likely to retain hygienic properties throughout a domestic working life. Since the bacteria are not visible to the eye, when cleaning up, the bacteria may not be removed (Holah and Thrope, 1990: Stevens and Holah, 1993). When preparing raw meat and other foods, it is very important to clean the surfaces completely with hot water rather than cold water, since most bacteria can survive in cold water.

Josephson (1997) studied whether the use of disinfectant cleaner would reduce the growth of bacteria. There were three phases in this experiment: in the first phase, the participants were people who did not use disinfectants when cleaning; the second phase consisted of participants who did use disinfectants when cleaning; and the third phase just consisted of evaluating the use of disinfectants on a regular basis. Participants who did use disinfectants were given the supplies needed, but they were not instructed on how to use the products or how often to use them. Samples were taken from eight different objects and places in the kitchen using Dacron swabs with filter-sterilized neutralizing solution. All the samples were taken in the morning and then kept on ice for later evaluation. They found that there was not that much of a difference between using disinfectants every once in a while (phase II) and not using disinfectants (phase I) to clean homes. When using disinfectants on a regular base (phase III), the amount of bacterial growth was lower. The authors conclude that, when using disinfectant cleaning supplies to clean homes, they do not completely eliminate bacteria growth, but reduce the counts of bacteria growth and make homes more bacteria-free.

The process of washing utensils and dishes before using them and after the preparation of raw food will remove organic matter and help to reduce cross contamination. It is very important to clean up after preparing and cooking foods, in order to prevent transmission of bacteria within the kitchen (Mattrick, 2003). In Mattrick's experiment there were two groups: the first group consisted of 52 people who had no formal hygiene training; and the second group consisted of people who were professional cooks, had food handlers' permits, and had training in preparing food the correct way.

Each group was assigned to prepare a certain meal which included raw meat, salad, and pasta, and were asked to prepare this meal the way they would normally prepare meals. In the conclusion of this experiment, Mattrick discovered that people who have no training on how to prepare foods and clean up tend to have a higher amount of cross-contamination and bacterial growth. Mattrick also concluded that properly trained cooks tend to use hotter water, which tends to kill bacteria, and they wash utensils prior to using them, such as plates, pots, forks etc.

These articles led me to my hypothesis because they do not mention the types of detergents or cleaning supplies used when conducting their experiments. Another reason is because the studies do not illustrate whether the use of antibacterial soap will lower the bacterial count or eliminate it completely. Due to sponges being a common cleaning supply in kitchens, I hypothesize that if antibacterial dish soap is used properly, it will reduce bacterial growth and cross-contamination in the kitchen. In the experiment I will be testing antibacterial dish detergent soaps and regular dish detergent soaps used on kitchen sponges. I think that antibacterial dish detergent will decrease bacteria growth more effectively than non-antibacterial dish detergent because antibacterial dish detergent is made to reduce bacteria growth. With these data, I will be able to determine if antibacterial dish detergent has a positive or negative affect on bacteria growth with the use of sponges in kitchens.

Methods

I ordered 120 regular O-cel-o sponges that were 4" x 3" x 0.6" in length from a retail market store. I cleaned the sponges with 0.05 % Palmolive regular dishwashing liquid in hot water (60-65 ^{o}C) to remove chemicals and preservatives, and then squeezed them to remove excess liquid. Once this was done, I rinsed three sponges at a time in a bag containing 300 mL of distilled water for five minutes. Then, I removed the sponges from the bag, rinsed them in cold water and squeezed them to remove the excess liquid. For the last step of the cleaning process, I boiled the sponges in distilled water for ten minutes, and I removed the excess liquid by squeezing them (Nielsen, 2002). I placed each sponge in its own Ziploc bag.

The reason I cleaned the sponges before I used them was because sponges often have a small amount of water and preservatives added to them. Also, sponges can be contaminated with bacteria and fungi, so it was important to clean them prior to the experiment (Nielsen, 2002). One reason water is added to sponges is so that the buyer can have a soft sponge once the bag is opened. The reason for added preservatives is to prevent growth after manufacture and prior to consumer use. Once in use, the preservatives are soon washed off the sponges, and the preservatives can have an effect on bacterial counts in experiments such as this (Erdogrul and Erbilir, 2003).

Once I had cleaned the sponges, I sent out an e-mail to all students living in the dorm rooms at Saint Martin's University who had a kitchen and asked them to respond back to me if they wanted to participate in my experiment. Since I did not receive enough responses from students in the dorm rooms, I used students off campus as well. I gave 10 participants one sponge each and a bottle of Palmolive antibacterial detergent and asked them to use it on a regular basis. I gave another 10 participants one sponge each and a bottle of regular Palmolive dishwashing detergent and also asked them to do the same as the other participants. Each participant used the same sponge for one week and received a new sponge at the beginning of the next week for three weeks.

For each week the sponges were used, I collected the sponges, added 10 milliliters of water to each sponge and let them sit for 5 minutes. Then, I squeezed the water out of the sponges into a dish and then transferred the liquid into a 3 ml cuvette, which had nutrient broth. I first placed a 3 ml cuvette into the spectrophotometer (Bausch & Lomb Spectronic 20) that contained nutrient broth and water and set the transmittance of the machine to 100 % and set the wavelength to 686 nm. I used the blank because, since the sponges were mixed with water and nutrient agar, I had to be able to determine the absorbance and transmittance of the water and nutrient broth by themselves in order to determine the absorbance and transmittance of the bacteria cuvettes so that it was more accurate. Then, I placed the test tubes with the bacteria in the spectrophotometer and recorded their % transmittance. Once I recorded the numbers from each sponge, I used the formula D= log (100/ %T) in order to calculate the optical density of each sponge. I used these same steps and instructions for each week of the experiments.

After the steps were completed, I compared the two groups of numbers, antibacterial and the regular dish detergents, by using a two sample t-test. The two sample t-test allowed me to be able to determine which dish detergent had a higher number of bacteria growth on kitchen sponges. All statistical tests were conducted using Minitab statistical software (Minitab Inc., 2005).

Sponges are the most commonly used cleaning material in homes. Sponges are also known for collecting a lot of bacteria on them if they are not discharged after a certain amount of usage. It is important to make sure that different sponges are used for certain areas of cleaning so that cross-contamination does not occur. It is also important to throw away sponges after they are used for a long period of time so that bacteria do not grow on them.

This experiment was performed for three weeks and included sponges and Palmolive antibacterial dish detergent and regular dish detergent. A total of twenty participants were involved in this experiment. Ten participants used antibacterial dish detergent, while the other ten used non-antibacterial dish detergent. The sponges were collected and incubated for 24 hours at 37^o degree Celsius for weeks 2 and 3.

Results

In the first week of collecting the sponges, some sponges were left out longer than others due to not collecting them all at the same time. Once they all were collected I placed the sponges in a glass bowl with distilled water and let them soak for five minutes. Then using a funnel I squeezed the liquid out of the sponges into a test tube that contained nutrient broth and mixed them together.

Using a spectrophotometer I measured each sponge's transmittance and absorbance. Figure 1 shows the measured optical density of bacterial growth from sponges which had been collected after 1 week of use. Each bar represents 1 sponge used by one participant for a week. Most bacterial growth was low, under 1.0 as measured by optical density.

In the second week of collecting the sponges I used the same procedures as I did in the first week, but this week sponges did not sit out because I was able to collect them all on the same day. The only difference was that after the liquid from the sponges was transferred into the test tubes that contained nutrient broth and was mixed together, the test tubes were placed in the incubator at 37^{o}C for 24 hours so that the bacteria growth would be more visible. Once the test tubes were taken out of the incubator, I used a funnel and transferred the liquid from the sponges into the cuvettes and measured their transmittance and absorbance with the spectrophotometer.

Figure 2 shows the bacterial growth from the 20 individual sponges which had been used for the 2nd week of testing. Again, bacteria growth was low, under 0.7 as measured by optical density.

In the last week of testing, week three, the same procedures were used as in week 2.

Figure 3 shows the measured optical density of bacterial growth from the sponges which had been collected after 1 week of use. Figure 3 also shows that most bacteria growth was lower than 0.4 as measured by optical density.

The mean optical density for week 1 sponges was 0.263 for sponges with antibacterial dish detergent and 0.193 for sponges with non-antibacterial dish detergent (Figure 4). Using a two sample t-test to compare the means, no significant difference in bacterial growth was found (t = 0.59; d.f. = 18; p = 0.560).

The mean optical densities for week 2 sponges were 0.262 for sponges with antibacterial dish detergent and 0.345 for sponges with non-antibacterial dish detergent (Figure 4). Using a two sample t-test to compare the means no significant difference in bacterial growth was found (t = -1.52; d.f = 18; p = 0.147) in bacterial growth on sponges with antibacterial dish detergent vs. sponges with non-antibacterial detergent.

The mean optical densities for week 3 sponges were 0.1957 for sponges with antibacterial dish detergent and 0.2241 for sponges with non-antibacterial dish detergent (Figure 4). Using a two sample t-test to compare the means, no significant difference was found (t = -1.53; d.f. = 18; p = 0.144) in bacteria growth on sponges with antibacterial dish detergent vs. sponges with non-antibacterial dish detergent.

These findings tell me that there was no significant difference between using antibacterial dish detergent vs. non antibacterial dish detergent on kitchen sponges.

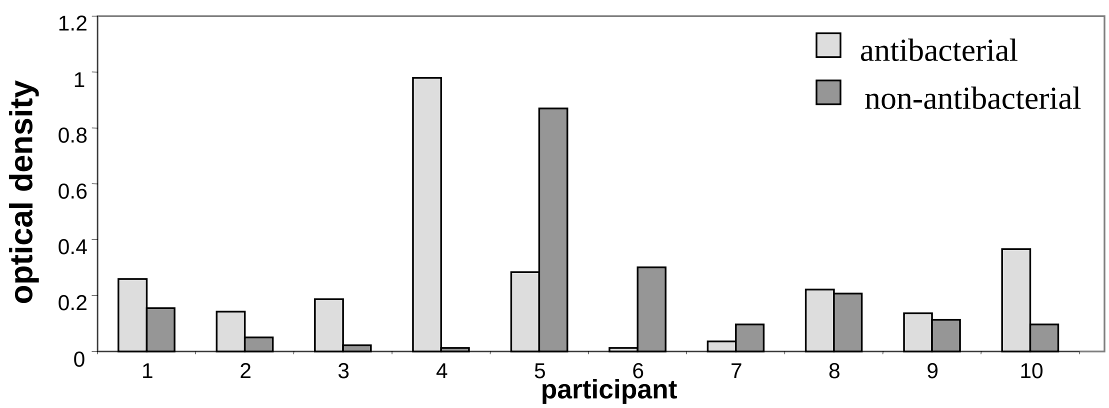

Figure 1. Week 1: Antibacterial Dish Detergent vs. Non-antibacterial Dish Detergent. Bacterial growth as measured by optical density on sponges with either antibacterial dish detergent or non-antibacterial dish detergent. Each bar represents the bacterial growth from one sponge given to a participant to use for one week. These sponges were not incubated before measuring bacteria growth.

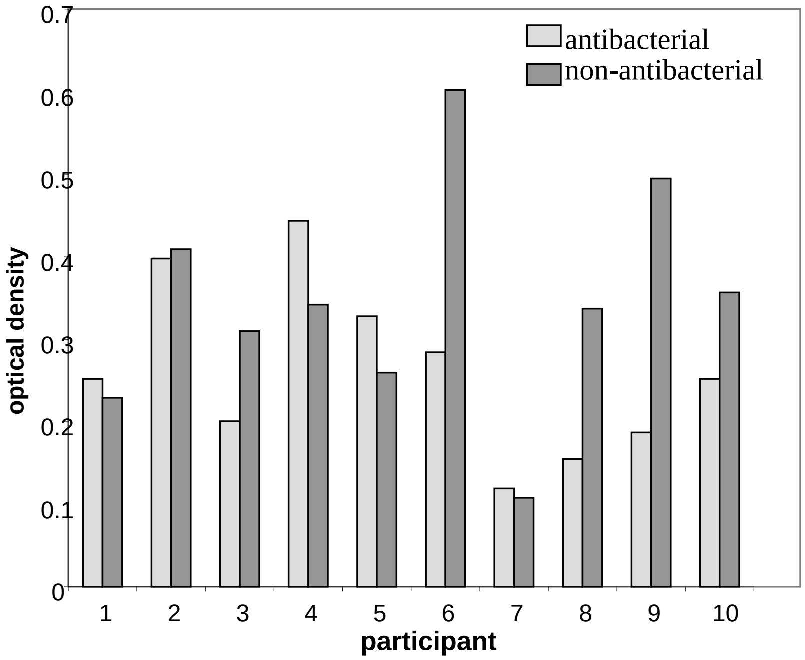

Figure 2. Week 2: Antibacterial Dish Detergent vs. Non-antibacterial Dish Detergent. Bacterial growth as measured by optical density on sponges with either antibacterial dish detergent or non-antibacterial dish detergent. The same participants were issued a new sponge for a second experiment lasting a week. Each bar represents the bacterial growth from one sponge given to a participant to use for one week. These sponges were incubated for 24 hours at 37°C before measuring bacteria growth.

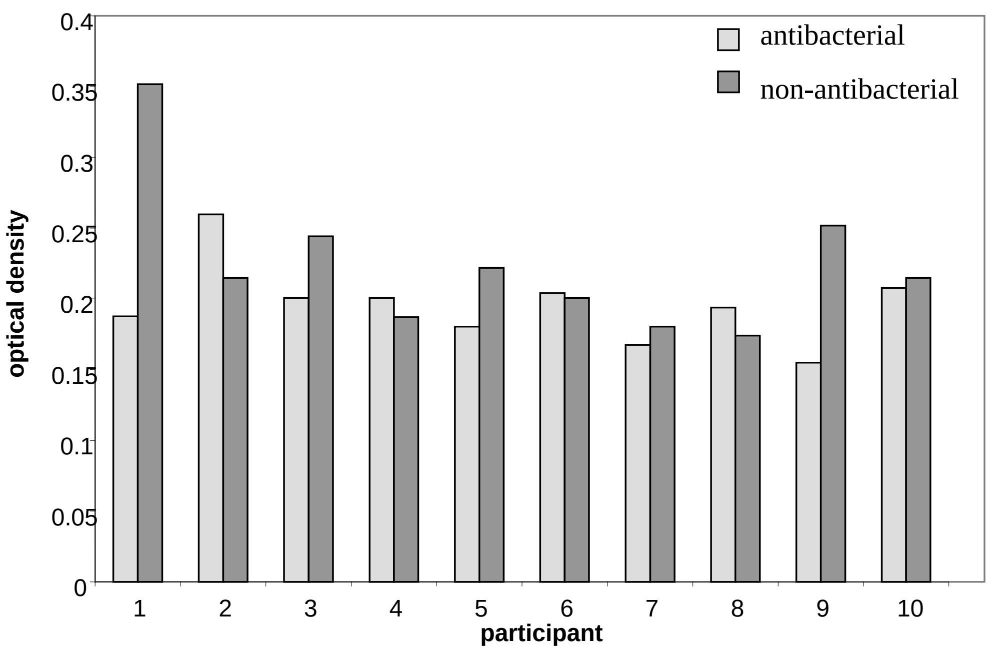

Figure 3. Week 3: Antibacterial Dish Detergent vs. Non-antibacterial Dish Detergent. Bacterial growth as measured by optical density on sponges with either antibacterial dish detergent or non-antibacterial dish detergent. The same participants were issued a new sponge for a third experiment lasting a week. Each bar represents the bacterial growth from one sponge given to a participant to use for one week. These sponges were incubated for 24 hours at 37° C before measuring bacteria growth.

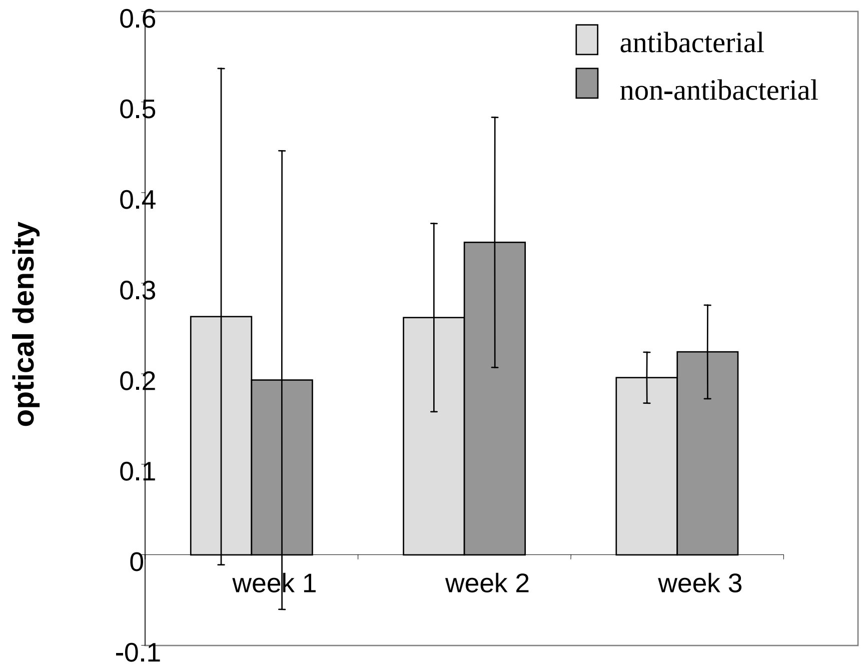

Figure 4. Mean of all three Weeks: Antibacterial Dish Detergent vs. Non-antibacterial Dish Detergent. Mean of bacterial growth as measured by optical density on sponges with either antibacterial dish detergent or non-antibacterial dish detergent. Each bar represents the mean bacterial growth from dish detergent that was used on ten sponges for each week. The error bars in each week represent the standard error in the values and indicate that there is no difference between the two detergents due to the error bars overlapping each other.

Discussion

From this experiment I expected to find that antibacterial dish detergent would have an effect on reducing bacterial growth on kitchen sponges causing the sponges to be less cross-contaminated when used multiple times on different surfaces. The reason I expected these results was because a product that is labeled antibacterial should help to kill bacteria at a higher percentage than regular products, no matter what the product is used on.

The results of my experiment for the first two weeks failed to support my hypothesis (d.f= 18; t= 0.55; p= 0.588), which stated that antibacterial dish detergent would have a greater effect on reducing bacterial growth in kitchen sponges than non-antibacterial dish detergent. These data indicated that not all antibacterial dish detergents are 100% effective at reducing bacterial growth as they are advertised (Nielsen, 2002). My interpretations are that not all antibacterial products prevent all bacterial growth and that some may cause more bacteria to grow depending on what you are using the product on. In my opinion, some companies may be putting the label "antibacterial" on their products, because they know that consumers will buy it since they are supposed to eliminate bacteria growth and that is were the money is at.

The reason why my null hypothesis was accepted in week three could have been that the sponges were collected at the same time and were taken into the laboratory the same day, so that they could be incubated for 24 hours before data was collected from them. As can be seen in Figure 3, allowing the test tubes to be incubated for 24 hours in a 37^{o} degree Celsius incubator permitted more bacteria to be present when data were collected from the sponges compared to Figure 1.

There are many possible explanations for the reason why the data collected from week one and week two had no significant difference when antibacterial dish detergent vs. non-antibacterial dish detergent was used. Leaving the sponges on the counter top in the lab for too long before actually collecting data from the sponges may account for part of the error. The sponges were on the counter in the lab for 2-3 days before data were collected from them. Not being able to pick up the sponges from every participant on the same day caused the sponges that were already collected to be stored in a zip-lock bag for 1-2 days. When sponges are left on a counter or table top for a long period of time without being used, it is possible that bacteria grew on the sponges, causing the sponges to collect more bacteria then they originally had.

Another possible explanation why I didn't see differences in bacterial growth could be due to the methods that were used to clean the sponges. Not drying the sponges after they were cleaned could account for some error. When sponges are not dried after cleaning, as mentioned in my methods section, the moisture on the sponges can cause bacteria to grow. That is why if the sponges are cleaned before an experiment, it is important to dry them. The reason why the sponges that were used were not dried was because there was not a clean and sanitized oven to place them into dry overnight. It is also possible that my methods were not precise enough to detect small difference in bacterial growth. I should have had larger sample sizes and allowed the participants to use the sponges for at least two weeks.

Some ways that this experiment could be modified are: making sure that if the sponges are cleaned, they are dried in an oven overnight so that the heat will kill all the bacteria. Another way is to make sure that a specific time is set for when the sponges will be collected, so that the sponges will not grow more bacteria before being tested.

A study done by Ojima (2002) indicated that most bacteria grow in the kitchen due to the countertops, cutting boards, and refrigerator doors being washed with the same sponges and dishcloth after preparing raw meat. This could be the reason why there was no difference between the two detergents because the same sponge was used to clean areas such as the kitchen countertops and refrigerator doors where bacteria can live and grow on as long as the temperature is between 50- 115^{o}F.

When trying to control the growth of bacteria in the kitchen area consumers should not use sponges or dishcloths because these two products can harbor bacteria and not even antibacterial dish detergent will help to reduce the amount of bacteria that grow on them. A study done by Erdogrul and Erbilir (2003) showed that using dishwashing detergent daily had no effect on fungal growth, *Pseudomonas* growth or *E. coli* growth. This study is similar to mine because it shows that no detergent will eradicate all microbial growth on kitchen sponges.

In conclusion, after completing my experiment to see if antibacterial dish detergent kills more bacteria on sponges than regular dish detergent I conclude that they both work poorly. Consumers who use sponges should make sure to either clean their sponge in a dishwasher or washing machine or to change their sponge once a week in order to reduce cross-contamination or bacterial growth.

Acknowledgments

I would like to thank my senior seminar professors Dr. Mary Jo Hartman and Dr. Margaret Olney for taking time out of their busy schedules to assist me with my research and my papers. Thanks to all of my participants who were in my study because without them I would not have had a study. To all my colleagues who edited my papers and made the many correction that were needed on them. Finally, I would like to thank my best friend, Ann Marie McCanick, for helping me with my research and for just being there for me when I needed her.

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