THE STUDY OF TOOTHPASTE AND TOOTH DECAY
Marie Andersen
Cary Academy

ABSTRACT
The purpose of this experiment was to see what brand of toothpaste prevented the most tooth decay. Acid causes tooth decay and an easy way to fix that is by using tooth paste. Eggs were covered in toothpaste and soaked in Mountain Dew. Sensodyne was the toothpaste that helped the most against tooth decay, egg decayed 0.14 g, and no toothpaste helped the least, egg decayed 4.1 g. It was determined that higher amounts of fluoride can help fight tooth decay.

INTRODUCTION
There have been three experiments done in the past about soda and teeth decay. The first one was to see which type of liquid affected an egg shell the most. The result of the experiment was vinegar because it was the most acidic. The egg shell gained 0.7 grams in 48 hours. The second experiment was if adding tooth paste to the egg shell affected the decay of the egg. The tooth pastes turned out to help the eggs not dissolve as much. The third and final experiment was to test the weight of the eggs after being soaked in different liquids. The chocolate milk affected the egg shells the most. The egg lost 0.226796185 grams. It was concluded, this was because of the pH level. The chocolate milk was 6.75 which reach to acidic levels just barely.
Tooth paste is 20 to 42 percent water to help the tooth paste not dry out. Fifty percent of the tooth paste is abrasives. Abrasives can include baking soda, calcium carbonate, calcium phosphates, alumina, and silica. These substances clean human teeth but high levels of abrasives can damage human teeth sensitive by weakening the enamel. Fluorides are also one of the most used ingredients used in tooth paste. Three types of fluoride are used. These are sodium fluoride (NaF), stannous fluoride (SnF2), Monofluorophosphate (Na2PO3F). Surfactant is a detergent that makes the tooth paste foam. Typically sodium lauryl sulfate (SLS) is the surfactant used in tooth paste. Antibacterial agents, Triclosan, are another ingredients used. To make the tooth paste taste good, many manufactures use flavors. The
most common flavor is mint, followed by peppermint, spearmint and wintergreen. Natural toothpaste brands often use more exotic flavors made from anise, fennel, lavender, and other plants. Calcium is the typically used element for Remineralization. Calcium helps strengthen enamel. Humectant is what gives the tooth paste texture and keeps in moisture. Glycerin, sorbitol, and water are common humectants. However, xylitol is the best type because increases the flow of saliva, which prevents dry mouth and tooth decay. Thickeners include carrageenan, cellulose gum, guar gum and xanthan gum. Preservatives (sodium benzoate, methyl paraben, and ethyl paraben) help avoid microorganisms from growing in the tooth paste. Sweeteners are put in tooth paste to improve the taste. Finding coloring agents such as artificial dyes is not uncommon in commercial tooth paste. The ingredients of tooth paste are weighed to make sure the ratios are accurate. Then they are put in a large vat to be mixed. The vat holds up to 10,000 tubes worth of tooth paste mixture. The tooth paste tubes are vacuumed and blown with high air pressure making sure the tubes are sanitary. The tubes are filled with tooth paste. Then the tubes get folded and sealed shut. The tooth paste works to remove plaque, a sticky, harmful bacteria that grows on human teeth that causes cavities, gum disease and ultimately tooth loose. The tooth paste also contains fluoride, which makes the entire tooth structure tougher to decay and helps Remineralization. Also it helps to prevent cavities and plaque. There are special ingredients in toothpaste that helps clean and polish the teeth and remove stains over time.

Acids and bases are the complete opposite. Acid means dour in Latin. Acid is a substance which creates hydrogen ions when added to water. Acid also reacts with bases to form salts and water. This is because when mixed together acids and bases neutralize each other out. Acid can change litmus, a blue vegetable dye, to red. It can also change hydrogen gas upon reaction with an active metal. These active metals include alkali metals, alkaline earth metals, zinc, and aluminum. Acid dissolves almost every substance it comes in contact with. There are more hydrogen ions in acid than there are hydroxide ions. Some household items that include acid are vinegar, aspirin, and toilet bowl cleaner. Vinegar is acetic acid, aspirin is acetylsalicylic, and toilet bowl cleaner is sulfuric acid. Acid tastes sour. Along with other acids there are also mineral acids. Some mineral acids are sulfuric, nitric, hydrochloric, and phosphoric. Carboxylic acid, sulfonic acid, and phenol groups contain hydrogen atoms that are released as positively charged hydrogen ions. Acid can be found in many fruits. Citric
acid can be found in lemons. The citric acid causes the lemon to taste sour. Tannic is taken form tree barks and is used to tan leather. Car batteries contain sulfuric acid. The acid found in fruit, vinegar, and stale milk is weak however the acid in car batteries burns skin and attacks metal. On the other hand, bases create hydroxide ions when added to water. Bases are particles that attract hydrogen ions from acidic molecules. Lye, bicarbonate of soap, and soap are all bases. Some bases dissolve in water. These bases are called alkalis. Bases usually feel slippery. Acidified litmus, red litmus, can be turned back to blue by a base. Sodium hydroxide is used to make soap. Ammonium hydroxide is used to remove ink form clothes and grease form windows. Not all bases are alkalies but all alkalies are bases. Alkalies are chemical compounds that dissolve in water. Unlike acids, bases have more hydroxide ions than hydrogen ions. Some house hold items that contain bases are baking soda, ammonia, and drain openers. Baking soda contains sodium bicarbonate, ammonia is ammonium hydroxide, and drain openers are KOH and NaOH. The strongest base is caustic soda. Caustic soda is found in oven cleaners.

![pH scale](image)

**Figure 1: pH scale**

Teeth are not bones, but stronger. Teeth help to break down food while a person is chewing. An adult has thirty-two teeth but a child only has twenty temporary teeth after they are three. Teeth have long roots that attach them to the jawbone. Teeth are made up of four main parts or layers. These parts are enamel, pulp, dentin, and cementum. On the outside of a tooth is a protective layer of enamel. Enamel is the hardest substance in the human body. The enamel covers the whole tooth above the gum. Below the enamel there is a bone like solid called the
dentin. The dentin makes up the largest part of the human tooth. The dentin shields teeth from wear and tear of chewing, protects against temperature changes, and supports the tooth’s enamel. Under the dentin, the tooth has a soft center called the pulp. The pulp has all the tooth’s blood vessels, connective tissue, and nerve endings. The pulp extends into the tooth’s root. The last main part of the tooth is the cementum. The cementum covers the tooth’s roots and holds the tooth in place below the gum line. Tooth decay starts with the enamel. The beginning of tooth decay has almost no pain because the tooth enamel has no feeling. When it reaches the dentin it can start to cause a toothache. If the decay spreads as far as the pulp it is an incredibly painful situation. In children between the ages of four and eight loose their milk teeth, also known as baby teeth. This is because the roots of their teeth begin to dissolve. Baby teeth fall out so permanent teeth can take their place. It is common to get permanent teeth a short period of time after a milk tooth falls out. It is ok to wiggle teeth but never attach a string on a baby tooth to pull it out. Pulling milk teeth before they are ready can cause the root to break or get stuck in the gum. This can lead to infections and other dental problems. Many teenagers drink soda and eat candy. Soda contains phosphoric acid, which can prevent calcium absorption. Also soda has a low pH level which decays teeth. Drinking soda and eating a lot of candy can cause permanent damage to teenagers’ teeth. Teenage girls are especially at risk because they get most of their bone mass by age 17 and need calcium to keep their bones and teeth strong.
MATERIALS & METHODS

In the experiments performed, eggs, mountain dew, tooth paste, mouthwash, a triple beam balance, plastic beakers, lemon juice, fluoride, baking soda, sweet tea, coke zero, and water were used.

In the first experiment, 300 mL of Mountain Dew was poured into a beaker. One brand of toothpaste was spread evenly on one egg with hands. Each egg was weighed before it was soaked. This was done with three other brands of toothpaste and one egg without tooth paste. The eggs were soaked in the Mountain Dew for 96 hrs. The eggs were taken out and weighed. The difference of the egg’s weight before and after was calculated and recorded.

In the second experiment, 300 mL of Mountain Dew was poured into 5 plastic beakers. 40 mL of 4 different brands of mouth wash was poured into the same beakers. An egg was weighed and then put in each beaker. The eggs were taken out after being soaked for 24 hr. The egg was weighed and then the difference in weight before and after being soaked was recorded.
In the third experiment, 2 mL of toothpaste, 5 mL of tooth paste, and 10 mL of toothpaste was added to different eggs. The eggs were weighed and then soaked in 300 mL of Mountain Dew for 24 hrs. the eggs were taken out, weighed, and the difference from before and after being soaked was documented.

In the fourth experiment an egg was weighed and then put in a beaker of 300 mL of Mountain Dew. The egg was weighed every 24 hr for 96 hr. The weight difference was measured each 24 hr.

In the fifth experiment 10 mL of baking soda, lemon juice, and fluoride was added to toothpaste. Each different ingredient and tooth paste was put on an egg. The eggs were weighed and soaked in 300 mL of Mountain Dew for 24 hr. Also plain toothpaste and no toothpaste were put on an egg. The eggs were weighed and the difference before and after being soaked was recorded.

In the sixth experiment 300 mL of lemon juice, sweet tea, water, mountain dew, coke zero was measured in a beaker. An egg was weighed and placed in each beaker. The eggs were soaked for 24 hr. After being soaked the eggs were weighed and the difference before and after being soaked was recorded.

In the seventh experiment 10 mL of baking soda, lemon juice, and fluoride were added directly to 300 mL of Mountain Dew. An egg was weighed and then soaked in the mixture for 24 hr. the egg was taken out and weighed. The difference in weight before and after was calculated.
RESULTS AND DISCUSSION

Figure 3: Tooth Decay of Different Toothpaste Brands

Sensodyne was the toothpaste that helped the most against tooth decay (0.14 g) while no toothpaste helped the least (4.1 g). Sensodyne is known to protect teeth from wine, fruit, and soda acids. Sensodyne toothpaste contains more calcium and fluoride than many other toothpaste brands. Fluoride works with hydroxyapatite to make a mineral that replaces and helps strengthen damaged or lost tooth matter. Even though teeth are not really bones, calcium helps strengthen human teeth. Teeth and bones contain a large part of the human body’s calcium so it is important that teeth get the calcium they need to keep up the levels of calcium. Without toothpaste teeth cannot get fluoride.
Without mouth wash the egg decayed the most (2.3 g at 20 hr and 4.1 g at 96 hr) and the best mouth wash brand was Listerine (0.3 g at 20 hr and 0.4 at 96 hr). Listerine mouth wash is 26.9% ethanol. Ethanol is pure alcohol. Ethanol is toxic to many oral bacteria which eat away at human teeth. In other words the ethanol in Listerine mouth wash kills a bacterium that causes tooth decay.
It was concluded that the more toothpaste the more it helps against tooth decay. The egg that had 10 mL of toothpaste decayed the least (1.4 g) and the one with 3 mL of toothpaste decayed the most (5.3 g). Toothpaste holds ingredients that support teeth enamel and fight against tooth decay. These ingredients are calcium, fluoride, and toothpaste has material that eats oral bacteria.

![Graph showing weight loss vs. time soaked](image)

**Figure 6: Decay of Egg for Different Amounts of Time Soaked**

The egg decayed the least when it was soaked for 24 hr (2.6 g) and the egg decayed the most when soaked for 96 hr (3.9 g). The acid in soda softens and erodes the tooth enamel. The acid in the soda eats at the protective layer of human teeth and exposes the weaker area. In some extreme cases, someone can lose a tooth by grinding their teeth. A drink that’s pH level is below 5.5 will cause tooth decay. Mountain Dew has a pH of 3.14 which means it is really acidic. The longer the eggs/teeth are exposed to these acids the longer the acids can eat away at human teeth/eggs.
Figure 7: If Adding Things to the Toothpaste Helps

Fluoride helped the most against tooth decay (0.45 g) and no toothpaste was the worst (3.9 g). Fluoride and hydroxyapatite work together to replace minerals that teeth lose because of tooth decay. Fluoride also kills bacteria. When a tooth decay minerals that were in the enamel get lost. The lost minerals get redeposited by minerals such as fluoride. Fluoride also helps with early tooth decay and makes a tooth more resistant to acid. Although humans can get some fluoride from their food, pure fluoride helps the most. Toothpaste already contains some fluoride already so mixing more fluoride doubled the amount of fluoride on the egg.
Figure 8: Type of Drink that Caused the Most Decay

An egg soaked in water caused the least amount of decay (1.8 g) while Lemon Juice caused the most decay (4.5 g). The lower the pH of a drink the more acid is in that drink. The lowest pH a drink needs to have to cause tooth decay is 5.5. Lemon juice had the lowest pH out of all the drinks, a pH of 2. This is well below acidic levels. The pH of water is a 7 which is considered a neutral. A neutral is basically not an acid. Acids will cause tooth decay because it wears down human teeth.

Figure 9: If Adding Things to Soda Helps Tooth Decay
Lemon juice helped the least with tooth decay (4 g) and fluoride helped the most (0.6 g). Lemon juice has a pH of 2 which is really acidic. Acid will consume teeth matter where as fluoride helps restore lost teeth matter.

CONCLUSION

The experiment showed that the Sensodyne toothpaste helped prevent tooth decay the most. This was expected as Sensodyne is often recommended by many dentists. The conclusion is important, as people will now know what toothpaste they should use to prevent tooth decay. Future experiments such as temperature of tooth paste, different types of teeth, or size or egg/tooth could be interesting to conduct.

CITATIONS


Cinoman, Matthew,"TESTING EGGS THAT ARE SOAKED IN DIFFERENT TYPES OF LIQUIDS.” Cary Academy, 2012.


