EXPERIMENTS TO DETERMINE THE PRESENCE OF BACTERIA IN DRINKING WATER

By

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AIM:

Have you ever wondered about how clean is the water that we drink from water coolers, the tap, bottled water and the coconut water from roadside vendors? The main aim of this experiment is to determine how much bacteria is in the waters that we drink and the water we swim in. Another aim is to determine how effective are some common antibacterial products such as mouthwash, hand sanitizer and lime.

BACKGROUND RESEARCH:

Bacteria are single-celled micro-organisms. Individual bacteria can only be seen with a microscope, but they reproduce so rapidly that they often form colonies that we can see. Bacteria reproduce when one cell splits into two cells through a process called binary fission. Under perfect conditions a single bacterium could grow into over one billion bacteria in only 10 hours! The individual bacteria are
BACKGROUND RESEARCH, CONT.

too tiny to see without a high-power microscope, but you can see the bacteria colonies. One can distinguish between different types of bacteria by the colour and shape of the colonies.¹

Bacteria come in all shapes and sizes. A bacterium can be shaped like a sphere (coccus), a rod (bacillus) or a spiral (spirillum). Bacteria are about 1000 nanometres in size (a nanometre is one millionth of a millimetre).²

Bacteria are commonly called *germs*. 🌟🌟🌟

Not all bacteria are bad. Most bacteria are useful. Here are some examples of good/useful bacteria:

- Bacteria which live in our intestines produce substances that help to digest our food.
- Some bacteria in the roots of peas and beans produce nitrogen which helps plants to grow.
- Some types of bacteria are used in making cheese, yoghurt and sourdough bread.
- Bacteria (usually dead or weak ones) are used to make vaccines.
- Bacteria are used to clean water in sewage plants.
- Bacteria can help clean up oil spills.
However, some bacteria can be harmful and could make us ill or could lead to death.

- Some bacteria can cause food poisoning, resulting in vomiting and diarrhoea (i.e. gastroenteritis).
- Some bacteria can lead to pneumonia – a serious respiratory illness.

That is why we must make sure that the food we eat and the beverages that we drink are clean and free of harmful bacteria.

**EXPERIMENTAL PROCEDURE:**

1. Water samples were collected from the following sources:

   a. A tap in northern St. James.
   c. Water coolers in two different public locations.
   d. Water from a name-brand water filter.
   e. Water from a water dispenser in a store.
   f. Coconut water from three vendors in different locations across the island.
   g. Two swimming pools – one private, one public
   h. Milk two days before the expiration date.
2. Vials containing agar was used to determine the presence of bacteria in the various samples. *Agar is a gelatinous substance that provides nutrients and a stable environment for bacteria to grow in.*

3. Each sterile vial contained a paddle with agar substance on either side of the paddle. One side detects fungus; the other side detects bacteria. The paddle was immersed into the liquid being tested for approximately 5 – 10 seconds until both sides of the paddle was coated with the liquid.

4. The vial was then tightly closed and placed in an upright position at room temperature for 24 – 36 hours. This is called the **incubation period**, which is the time it takes for the bacteria colonies to form.

5. After 24 – 36 hours the paddle is examined for the presence of bacteria and fungus.

6. The chart below shows what the observations mean.

7. Once the results were recorded, the vials were placed in the refrigerator to slow down the further growth of the colonies.
EXPECTED RESULTS:

- I thought that the tap water would be clean and that the water cooler water would also clean because the water is cold.
- I also thought that the public pool would have lots of bacteria because lots of children and adults were playing in it.
- I expected that the water cooler might have a bit of bacteria in it because the cooler appeared to be dirty.
- I expected that some of the coconut water might be clean and some dirty, because the plastic bottles and cutlasses used might be dirty.
- I also thought that the milk was clean because it tasted okay.

ACTUAL RESULTS:

The actual results are shown in the table on the next page. Readings of $10^3$ or less are considered safe. Values above this suggest unsafe levels of bacteria and fungus.
**ACTUAL RESULTS:**

The results of the experiments are shown in the table below. The unit of measurement for bacteria and fungi is *colony forming units per millimetre* (cfu/ml). All measurements were taken after 36 hours.

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Bacteria (cfu/ml)</th>
<th>Fungus (cfu/ml)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap Water (St. James)</td>
<td>$10^2$</td>
<td>$&lt;10$</td>
<td>Fairly safe</td>
</tr>
<tr>
<td>Tap Water (St. Michael)</td>
<td>$&lt;100$</td>
<td>$&lt;10$</td>
<td>Quite safe</td>
</tr>
<tr>
<td>Purified bottled water</td>
<td>$&lt;100$</td>
<td>$&lt;10$</td>
<td>Quite safe</td>
</tr>
<tr>
<td>Brita filtered water</td>
<td>$10^2$</td>
<td>$&lt;10$</td>
<td>Fairly safe</td>
</tr>
<tr>
<td>Water cooler 1</td>
<td>$10^2$</td>
<td>$&lt;10$</td>
<td>Fairly safe</td>
</tr>
<tr>
<td>Water cooler 2</td>
<td>$&lt;100$</td>
<td>$&lt;10$</td>
<td>Quite safe</td>
</tr>
<tr>
<td>Coconut Water 1</td>
<td>$10^5$</td>
<td>$10^4$</td>
<td>Ugh!!! <strong>Harmful</strong></td>
</tr>
<tr>
<td>Coconut Water 2</td>
<td>$10^7$</td>
<td>$10^2$</td>
<td>Disgusting! <strong>Harmful</strong></td>
</tr>
<tr>
<td>Coconut Water 3</td>
<td>$10^2$</td>
<td>$&lt;10$</td>
<td>Fairly safe</td>
</tr>
<tr>
<td>Private Pool</td>
<td>$&lt;100$</td>
<td>$&lt;10$</td>
<td>Very safe</td>
</tr>
<tr>
<td>Public Pool</td>
<td>$&lt;100$</td>
<td>$&lt;10$</td>
<td>Very safe</td>
</tr>
<tr>
<td>Store Water Dispenser</td>
<td>$&lt;100$</td>
<td>$&lt;10$</td>
<td>Very safe</td>
</tr>
<tr>
<td>Milk ( 2 days before expiration)</td>
<td>$10^5$</td>
<td>$&lt;10$</td>
<td>It’s not that safe</td>
</tr>
</tbody>
</table>
HOW EFFECTIVE ARE COMMON HOUSEHOLD PRODUCTS IN FIGHTING BACTERIA?

EXPERIMENTS:

The following household products were tested to determine how effective they were in destroying bacteria:

- Mouthwash
- Hand sanitizer
- Lime

Petri dishes containing agar was used in these experiments.

To Test The Mouthwash:

1. A sterile cotton swab was used to collect sample from a person’s mouth. The swab was then smeared all over the agar in the petri dish. This procedure transferred any bacteria from the swab on to the agar, where it will grow. The dish was then covered and sealed and stored at room temperature.

2. The mouth was then washed with generous amounts of a popular mouthwash. The mouth was swabbed again and the procedure outlined above was repeated. After 24 hours, the samples in the petri dishes were observed and compared. The findings are presented below.
To Test The Hand Sanitizer:

1. A cotton swab was used to wipe my dirty hands at the end of a normal day. The swab was then smeared all over the agar in a petri dish.
2. My hands were then washed with generous amounts of a hand sanitizer and then swabbed again. The swab was then smeared all over the agar in another petri dish. After 24 hours the petri dishes were examined.
3. The results obtained were a bit puzzling, so we repeated the test. This time, after washing my hand with the sanitizer, my hands were wiped with a paper towel and then swabbed. The swab was smeared over the agar in another petri dish and left for 24 hours. The results were different this time. See the petri dishes on display.

To Test the Effect of Lime:

We did a test just like the one we did for the hand sanitizer, but this time, my hands were rubbed with lime juice, instead. The results of the tests are described below:

Expected Results:

I thought that the mouthwash, lime juice and the hand sanitizer were all going to make my hands and mouth cleaner. Therefore, I expected to see less bacteria in these samples.
FINDINGS:

1. The Effect of the Mouthwash:
   There were much fewer of the larger bacteria after using the mouthwash, but many of the smaller ones remained. This proves that the mouthwash destroyed certain types of the bacteria, but not all.

2. The Effect of the Lime Juice
   There was a big difference. There were fewer bacteria than before and now my hands are cleaner than ever!

3. The Effect of the Hand Sanitizer:
   The first experiment did not show much difference between “before” and “after” the use of the sanitizer. The bacteria stayed on my hands but formed a different pattern.

   When the experiment was repeated, and my hands were wiped, there was a big difference. There were fewer bacteria in the “after” sample this time.
CONCLUSIONS:

1. There were so much bacteria and fungus in the coconut water because the plastic containers may not have been washed properly. Also, the knives the vendors used may have been dirty. The coconut water which came directly from the coconut was much cleaner.
2. Bacteria were in the milk maybe because it was in the warehouse too long.
3. There were bacteria in the water from St. James because many of the pipes in this area are rusty and may carry germs. The amount of bacteria was not very high, so the water is still fairly safe.
4. The tap water in St. Michael probably came from the desalination plant and there were no reports of rusty pipes in this area, so the water was clean.
5. A small amount of bacteria showed up in the Brita filtered water because the water was from the tap in St. James, which also showed traces of bacteria.
6. There were no bacteria in the bottled water because they purified the water before it was bottled.
7. There were no bacteria in the water from the cooler, maybe because the water is cold, but the surface of the cooler was dirty.
8. Surprisingly, the hand sanitizer did not seem to have much effect on the bacteria – only after my hands were wiped and it only killed about 70% of the bacteria, even though the bottle said that it kills 99.9% of bacteria. Maybe because the alcohol in the sanitizer was too mild for the type of bacteria that were on my hands.
CONCLUSIONS, cont.

9. Another surprise was the public swimming pool water. There must have been a lot of chlorine in the water and it destroyed all the bacteria.

10. The lime worked very well on the bacteria. It did not kill all the bacteria though, just about 80%. So lime is good to clean dirty hands and surfaces.

11. The mouthwash did have a significant effect on some of the bacteria from the mouth. It killed most of the round, yeast-like bacteria, but most of the tiny ones were still there. These may be the ones that cause strep throat.

So from these experiments, we can say that:

- Most of the water we drink around Barbados is safe, except for the coconut water in the plastic bottles.
- Mouthwash destroys certain types of bacteria.
- Lime is also a good destroyer of bacteria.
HOW CAN WE PROTECT OURSELVES FROM HARMFUL BACTERIA?

We can control the spread of harmful bacteria by practicing good hygiene and following the rules below:

1. Always wash your hands with soap and water before eating.
2. If you are unsure about the safety of tap water in your area, make sure that you drink only purified water. Water can be purified at home by boiling or by using chlorine tablets.
3. Make sure that food and drink containers are clean before using. Plastic containers tend to harbour bacteria, so make sure that these containers are cleaned regularly. To be sure bacteria does not develop, or to kill existing bacteria, mix a solution of 10% chlorine or household bleach with 90% water and fill plastic bottles with the solution. Soak for 1 minute, then rinse thoroughly.
4. Never share your water or drinks bottle with others – not even your friends, they have germs too!
5. The mouth contains large amounts of bacteria, so Do NOT use other people’s toothbrushes and DO NOT eat food that has been bitten by anyone else – not even your mother.
6. Do NOT leave food and drinks in the sun for a long time, put them in fridge or a cooler full of ice so that bacteria will not grow in the food or drink. Most bacteria like warm places.
Sources of Water Used in the Experiments

Water Dispenser
Bottled Water
Water Cooler
Tap Water

Coconut Water from Roadside Vendor
Milk - 2 days before Expiration Date
Swimming Pool
Sources of Information:


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