**What Does Our Water Has To Tell Us?**

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**Introduction:**

The purpose of the experiment was to check the quality of different types of water sources available to us. The quality of water was determined by using the results found from several different tests that were preformed during June 16- June 23. It is no secret that we as humans have to have to drink freshwater in order to survive.

 There are several different types of water including salt water, saline water, and freshwater. The main focus of this lab was the freshwater supplies that were collected. Freshwater is found in places such as streams, rivers, and most lakes. Some companies have found a way to take the freshwater supply, “clarify” it, bottle it, and then sell it to the public.

The water used for the experiments in this lab include: 3 different water samples collected from 3 different rivers found inside Harlan County (Site 1: Lynch KY, Site 2: Hiram KY, Site 3: Harlan County High School KY), 2 samples of bottled water (Dasani and Cumberland Gap), 1 tap water source brought in from Harlan County, and 1 tap source that was brought in from Bell county. The tests that were conducted include: coliform bacteria (C.B.), dissolved oxygen (D.O.), biochemical dissolved oxygen (B.O.D.), nitrate, pH, phosphate, temperature, saturation, and turbidity.

In addition to water, soil from HCHS was also collected to help further the ability to determine the quality of the water source. Soil affects the river because contents from the soil go into the river during run-off. There were several different procedures/tests that were used to help determine the quality of the soil found at the testing site. They include soil texture, used to determine what type of soil the sample is (clay, silt, sand, loam, or a mixture of those), soil pH, potassium level, phosphorus levels and nitrogen. A nutrient extraction test was also conducted then a extraction dilution after that.The lab did involve some chemicals so it is advised, if conducting, to use the proper precautions needed.

**Materials:**

For this lab, test tubes were used (both small and large) along with testing bags. Several containers were used to collect the water samples. The LaMotte low cost water monitoring kit was used. The kit contained several testing tablets which include: C.B. test tab, phosphate tablets, D.O. tablets, nitrate tablets, and pH tablets. The same kit also included a thermometer strip, and secchi disk icon stickers. In order for you to analyze the results LaMotte also included a very useful guide to explain what certain things in the experiment are and a color chart guide for using the colors obtained from the experiments to find out what the results mean. Another different set of tablets was used to test the soil samples, they include: nitrate testing tablets, pH tablets, potassium tablets, phosphorus tablets, and Flox-Ex tablets. A color guide poster was used when dealing with results of the tests. During the soil collecting we used a trowel and a brown paper bag. For the disposal of the C.B test we used household bleach.

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**Procedures:**

**Water Testing:**

Collecting a water sample:

1. Remove cap from container and wear protective gloves.
2. Rinse the bottle 2-3 times with river water.
3. Hold container near the bottom of the river and turn it into the current.
4. Allow water to flow freely into the container for 30 seconds.
5. Cap container while is it submerged in river and remove.
* Remember to test and record the temperature of the water at every site.

Temperature: Temp. is a very important aspect to consider when testing the quality of water. The temperature not only affects the D.O. levels in the water but also photosynthesis of the plants, and the organisms in the water. A temperature can rise due to discharge of thermal pollution that comes from sources such as industrial operations.

1. At each, testing site wear protective gloves and place the thermometer strip approx. 4 inches under the surface and wait for one minute.
2. Remove the thermometer and record the temperature in degrees Celsius.

Tap water source:

1. Turn on faucet and allow to run for several minutes.
2. Collect water sample directly into container by holding it under the source until it over flows.
3. Cap the container and remove it from water.

Coliform Bacteria: C.B. is bacteria found in the human digestive tract and are not found in unpolluted waters. A source is considered positive if it had more than 20 coliform colonies per 100 mL of water, while negative has less than 20 colonies per 100 mL of water. The presence of C.B indicates sewage contamination. A test is positive if the gel rises to the surface, turns yellow, and the liquid below gel is cloudy. A negative test shows liquid above gel as clear, gel stays at bottom of tube and indicator turns red.

1. Pour water into large test tube containing a C.B. test tablet to the 10 mL line.
2. Place cap onto tube and stand tube upright with tablet on the bottom.
3. Store tube upright for 48 hours, out of direct sunlight.
* After test is FULLY complete and results are noted remove the cap and add approx. 1 mL of bleach and immediately recap. Then allow tube to stand upright for 4 hours. After time has elapsed put closed tubes in the trash. Do NOT open the tubes.

Dissolved Oxygen: D.O. is the amount of dissolved oxygen avaible A higher the D.O. level means the more stable and healthy environment that can support a variety of aquatic organisms. Cold water can hold more D.O. than warmer water can.

1. Record water temperature.
2. Submerge small tube into water sample and fill to the top.
3. Drop two DO test tabs into the tube. Water may over flow due to this.
4. Screw cap back on and mix by inverting the tube until tablets are gone.
5. Wait 5 more minutes for a color to develop and then compare to approtiate section on color guide chart.

Saturation: Saturation is a very important aspect of water quality. The higher the saturation the better the sample is.

1. Look at the temperature of the water sample at the test site. Then take the D.O results and use the two together to determine the % of saturation.
2. This should be recorded as a percentage.

Biochemical Oxygen Demand (B.O.D.): B.O.D is the amount of oxygen avaible to bacteria to use to break down wastes. Low B.O.D indicates slow moving or polluted rivers.

1. Submerge small tube into water sample and fill to the top.
2. Cap the tube and wrap it with aluminum foil and store it in a dark area for 5 days.
3. After time is complete unwrap the tube and place 2 D.O. tabs into the tube.
4. Recap the tube and invert until tabs have dissolved then wait 5 minutes.
5. Compare the color of sample to the D.O. section of the color chart guide.

Nitrate: After a plants or animals have died and they decompose in water they release nitrate into the water. Excess levels of nitrate will increase plant growth and cause the levels of oxygen in the water. Sewage is one of the main sources of excess nitrate and if drinking water has high nitrate levels it can affect the blood carrying the oxygen the bodies need.

1. Fill a test tube to the 5 mL line with the water sample.
2. Add one nitrate tablet into tube and cap.
3. Mix the sample by inverting for approx. 2 minutes, also bits of tablets may still be present after the 2 minutes.
4. Wait for 5 minutes until a red color develops. Take the sample and compare the colors to the Nitrate section of the color chart guide.

pH: pH measures levels of acidity in the samples. On the scale anything below 7 which means 6-0 are considered acidic, while anything above 7 which takes in 8-14 is considered very basic. A 7 on the scale is neutral and is the level that water needs to be at. pH is a very delicate aspect and the aquatic organisms can be very sensitive to this.

1. Fill a test tube to the 10 mL line with water sample.
2. Add one pH test tab and cap
3. Mix the sample by inverting until tablet is dissolved.
4. Compare the color of the sample to the pH range color on the color guide chart.

Phosphate: This is a nutrient needed for plant and animal growth. The higher these levels are, the less D.O. levels. Phosphate comes from human and animal wastes, agricultural run-off, and things such as those.

1. Fill a test tube to 10 mL with water sample.
2. Add one Phosphorus testing tablet to sample.
3. Cap and invert until tablet has disintergrated.
4. Wait for 5 minutes for a bluish color to develop.
5. Compare the color to the Phosphate color section on the color guide chart.

Turbidity: Turbidity is how clear the water is. Clarity is determined by particles floating in the water. Turbid waters can be caused by soil erosion, run-off, algal blooms, and sediment disturbances.

1. Remove the secchi disk icon sticker and place it on the bottom of the container, slightly off center.
2. Look into the sample and use the Turbidity section of the color guide chart and compare them.
3. Record the level of Turbidity in JTUs.

**Soil Testing:**

Soil sample collection:

1. Use a trowel and loosen the soil sample.
2. Collect soil from approx. 2-6 inches deep.
3. Take small a few small samples from the same area and mix them together
4. Mixing them will give you the “average” sample. You should have about a cup of “average” soil.
5. Record where the soil was taken and return to lab.

Soil texture:

1. Spread soil out on a piece of paper and record what is seen.
2. Pick out anything not soil such as rocks, leaves, twigs. Set them aside and then crush small lumps of soil.
3. Wet your fingers using water (it does NOT have to be your water samples.)
4. Rub the soil on your wet fingers and think about the texture.
5. Record the texture and determine what type of soil the sample is.

Nutrient Extraction:

1. Pour ½ cup of distilled water into a quart size zip top bag.
2. Put in 8 Floc-Ex tablets, seal the bag and shake until the tablets are disinrgrateed.
3. Open the bag and add approximately 5 teaspoons of soil, close bag and shake for about a minute.
4. After that hold bag at an angle and allow the particles to settle to one side.
5. After settling has occurred then open the bag and pour out the liquid into a paper cup.

Nitrogen:

1. Fill a test bag to line C (marked on the bag) with the soil nutrient extract (S.N.E). Being 100% accurate on this measurement will not affect the outcome.
2. Add one Nitrate test tablet #1. Roll the bag down and shake until tablet dissolves. DO NOT SQUEEZE THE BAG!
3. Open the bag and add one Nitrate test tablet #2. Re-roll the bag and shake until tablet is gone.
4. After shaking wait 3 minutes for a pinkish color to develop.
5. Compare the result color to the color chart poster. Record your results.

Potassium:

1. Fill a test bag to line C with S.N.E.
2. Add one potassium test tablet. Roll the bag down a few times and fold the yellow tabs back around the bag. Shake until tablet is gone.
3. Compare the “cloudiness” of the sample to the approiate section on the color chart poster.
4. Record results.

Soil pH:

1. Fill a test bag to line C with DISTILLED water.
2. Use a spoon to add about ½ tsp. of soil.
3. Add one soil pH testing tablet. Roll down the bag, fold the yellow tabs back and shake for 15 seconds.
4. Let bag sit for 1 minute.
5. Compare the color of the liquid above the soil to the correct section the color guide poster.
6. Record the results.

Soil Nutrient Extract Dilution/ Phosphorus test:

1. Put 7 tsp. of distilled water in a cup. Add one tsp. of soil extract and stir.
2. Fill a bag to line C with the diluted soil extract.
3. Add one phosphorus test tablet. Roll the bag down a few times and shake until tablet is gone.
4. Wait 5 minutes for a blue-ish color to develop.
5. Compare the color of the sample to the phosphorus section on the color guide poster.
6. Record results.

**Data and Results:**

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| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Dasani | CumberlandGap | Site 1: Lynch KY | Site 2: HiramKY | Site 3: HCHS KY | Harlan Co. tap KY | Bell Co. tap,KY |
| C.B. | Positive | Negative | Positive | Positive | Positive | Negative | Negative |
| D.O | 5 ppm | 5 ppm | 4 ppm | 4 ppm | 4 ppm | 4 ppm | 8 ppm |
| B.O.D | 8 ppm | 4 ppm | 4 ppm  | 4 ppm | <4 ppm | <4 ppm | <8 ppm |
| Nitrate | <5 ppm | <5 ppm | <5 ppm | <5 ppm | <5 ppm | <5 ppm | <5 ppm |
| Phosphate | <1 ppm | <1 ppm | 4 ppm | <1 ppm | 2 ppm | 2 ppm | <1 ppm |
| pH | 7 | 8 | 8 | 8 | 8 | 8 | 8 |
| Turbidity | 0 JTU | 0 JTU | 0 JTU | 40 JTU | 0 JTU | 0 JTU | 0 JTU |
| Temperature | 24C | 24C | 18C | 20C | 20C | 26C | 26C |
| % Saturation | 48% | 48% | 42% | 44% | 44% | 49% | 99% |

**Discussion:**

The results above may not be clear to someone who does not know what they mean and how to use them to determine the water quality. Some of the results will be shocking. The coliform bacteria test is a very important section in the lab. As stated above, C.B. is bacteria found in the human digestive tract and are not found in unpolluted waters. A source is considered positive if it had more than 20 coliform colonies per 100 mL of water, while negative has less than 20 colonies per 100 mL of water. The presence of C.B indicates sewage contamination. A test is positive if the gel rises to the surface, turns yellow, and the liquid below gel is cloudy. A negative test shows liquid above gel as clear, gel stays at bottom of tube and indicator turns red. All 3 of the river testing sites turned out positive for C.B. This was expected from them especially site #2 (Hiram, KY) because it was collected close to a place that had horses and mules present. A plus though is that both tap water sources turned negative. The Cumberland Gap water tested negative. The Dasani water on the other hand yielded perhaps the most shocking results, it tested positive for the C.B., meaning that there was fecal/sewage matter in the water.

The next test preformed was the dissolved oxygen. D.O. is the amount of dissolved oxygen avaible. The higher the D.O. level means the more stable and healthy environment that can support a variety of aquatic organisms. Cold water can hold more D.O. than warmer water can. A medium level of D.O. is at 4 ppm, while the lowest is 0 ppm and the highest is 8 ppm. Sites #1-3 all had 4 ppm, they exhibited peachy colors and had medium levels of D.O., that was an expected result. Both Dasani and Cumberland Gap produced 5 ppm showing off dark peach colors, which is not the best but it is still pretty good. The tap from H.C. had 4 ppm, showed a peach color and had a medium level of D.O. The B.C water showed 8 ppm had a dark-medium orange color and had a very high level of dissolved oxygen. That is a very good result especially from the tap source. Temperature is a very important aspect to consider when testing the quality of water. The temperature not only affects the D.O. levels in the water but also photosynthesis of the plants, and the organisms in the water. A temperature can rise due to discharge of thermal pollution that comes from sources such as industrial operations. The level of dissolved oxygen was combined with the temperature at the river sites to help determine saturation. High levels of saturation were expected in the results. 100% sat. is the best 50% is medium and below that is poorer. Site #1 had a sat. of 42% which is slightly below medium level. Sites # 2 & 3 both had a 44% sat. which is still below the medium level but it is not terrible. Dasani and Cumberland Gap both had a sat. of 48% which is still good but again not the best and that was yet again unexpected. The test performed after that was the B.O.D test which shows the amount of oxygen aviable to bacteria to use to break down wastes. Low B.O.D indicates slow moving or polluted rivers. High B.O.D levels show cleaner, faster moving currents. Sites # 1 & 2 showed a B.O.D of 4 ppm, they showed a peachy color. That is a decent result. The H.C water showed less than 4 ppm and had an almost clear coloring. While the B.C water had <8 ppm, that sample had a color slightly below the 8 ppm mark. Those were good results. The Dasani water had a B.O.D of 8 ppm, its color was a burnt orange and had a high level of B.O.D. The Cumberland Gap water had 4 ppms and that was at a medium level with a peachy color to it. Most of those results were expected.

Now, the nitrate test shows how much nitrate is in the water. After plants or animals have died and they decompose in water they release nitrate into the water. Excess levels of nitrate will increase plant growth and cause the levels of oxygen in the water. Sewage is one of the main sources of excess nitrate and if drinking water has high nitrate levels it can affect the blood carrying the oxygen the bodies need. Low levels of nitrate are expected. ALL samples (Dasani, Cumberland Gap, both taps, and all 3 river sites) tested <5 ppm for nitrate. They all showed a very light peach color it was almost clear. Those results are very good and were nothing but expected. Another test series conducted was the phosphate tests. Phosphate is a nutrient needed for plant and animal growth. The higher these levels are, the less D.O. levels. Phosphate comes from human and animal wastes, agricultural run-off, and things such as those. Low levels of phostphate are good 1 ppm, that is the best level, the medium level is 2 ppm and the high levels are at 4 ppm. Site #1 showed 4 ppm (dark blue color), Site #2 showed <1 ppm (very light blue), Site #3 had 2 ppm (a dull blue color). Dasani and Cumberland Gap both showed <1 ppm being a very light blue. This was a great result from them, but still being as they were “better” quality bottled water they were expected to yield those results. The tap water from H.C had 2 ppm showing a dull blue color. The B.C. water had <1 ppm which is very good for tap water. The next tests conducted were the pH tests. The pH measures levels of acidity in the water samples. On the accepted pH scale anything below 7 (which means 0-6) are considered acidic, while anything above 7 (which takes in 8-14) is considered very basic. A 7 on the scale is neutral and is the level that water needs to be at. The pH is a very delicate aspect and the aquatic organisms can be very sensitive to this, so it has to be in a good balance in order for everything to be normal. The Cumberland Gap water, Sites #1-3, H.C. water, and B.C. water all had a pH of 8. 8 pH has a duller green color and is not completely neutral but it is still very good. The Dasani water testd a 7 which is neutral and is considered the best test result. A 7 on the pH scale shows a brighter green color. The final test results shown was the turbidity. Turbidity is how clear the water is. Clarity is determined by particles floating in the water. Turbid waters can be caused by soil erosion, run-off, algal blooms, and sediment disturbances (caused by things like boat traffic). The lower the turbidity the clearer the water, 0 JTUs of turbidity is the best being extremely clear while 40 JTUs of turbidity means the water is slightly cloudy and 100 JTUs of turbidity means that the water is very murky and hard to see through. Site #2 had 40 JTUs of turbidity it was slightly cloudy but you were still able to see through to the sticker. All other samples had 0 JTUs which is great that means the water is very clear.

The soil tests, showed that the type of soil found at the site was silt. This means that the soil felt silky, smooth, and much like the way flour feels, and it did not stick to the person conduction the experiments hands. The coloring was a medium brown while it had some organic materials in it like rocks and stringy materials, however no bugs were found. The particles of the soil itself were smaller with a couple of larger ones in there also. First test was the pH test. The pH of soil determines what type of plants can grow there. The pH of the sample soil was a 7, which means a variety of plants can grow there. One soil test was the nitrogen test, nitrogen is important because plants grow in the soil and a plant that doesn’t have enough nitrogen will have yellow leaves. Too much nitrogen means plants can have long week steams. The tests showed low levels of nitrogen in the soil. That is an unexpected result. Next, is potassium tests. A medium level is wanted here too because too much potassium can cause the plant not to get enough calcium, and too little potassium gives small and browning leaves. The test results showed high levels of potassium, which is not good. Finally, the phosphorus was tested. Phosphorus again is a level that needs to be at a medium, and if given to little phosphorus can have a poor root system and too much phosphorus usually does not show any symptoms. The results showed low levels of phosphorus, which is not good.

 Humans are not perfect any possible sources of error in this lab could have been caused by simple human mistakes, such as miscalculations, false test results due to a cross contamination of water samples, not measuring adequately, and maybe the water at the sites was not an accurate reading of the whole river itself.

 This lab, when/if conducted again can be improved by simply taking more time to measure more precisely and double and maybe triple test the experiments to make sure that a result is re-occurring.

**Conclusion:**

 In conclusion, the river water samples are not the best water a person could drink, however you could drink it if you HAD to. The bottled water, which is sold to the public claiming to be better than tap water, had some good results. The worst result obtained from bottled water was the fact that the one sample of Dasani water tested positive for B.C. Now, it can be concluded, that out of all of the water sources tested, tap water proves to be the best currently. All of their levels were at good standings nothing to extremely high and nothing really low, they both tested negative for B.C. and they had good saturation and turbidity levels.

* The results of this experiment are not to be taken as solid evidence against bottled water, or any of the test samples. The results shown are just of a single set of tests that may have been effected by anything unseen/ unknown and simply represent a group of student’s findings. The tests were conducted in a high school science lab. If, you do not agree to the findings you may be able to recreate the above experiments and record your own results for your personal self.

**WORKS CITED:**

* LaMotte; Low cost water monitoring kit.