

Title: A NOVEL APPROACH TO NEUTRALIZE COLA

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ABSTRACT

The research question is: Can “impurities” in cola be removed through filtration? The “impurities” I will attempt to filter is the color and level of acidity and bring the cola back to water (H₂O). This research is Important because people need clean water and they will need to filter all of the impurities, so this research will find out which water filter is the best for filtering such an acidic beverage like cola. Because cola is so acidic, cola can dissolve a nail, and is very bad for your teeth. The research hypothesis is the reverse osmosis process will neutralize the acid in the cola better than filtration straws, water filter, and natural filtration. When preparing this project, a turbidity tube and pH paper testing strips were used. When testing turbidity, the filtered cola was poured into the tube and drained it until the secchi disk could be seen. The results for turbidity were mostly 1 to 3 cm for all filters except for reverse osmosis (RO), which had a turbidity level greater than 100 cm. When testing pH, the filtered cola would be poured into a dish and then pH would be tested. The results for pH were Brita and Life Straw filters getting pH levels of 4 and natural filter getting a pH level of 6 and reverse osmosis getting a pH level of 7. In conclusion the reverse osmosis process is the best for filtering out acidity in liquid cola.

INTRODUCTION

The research question is: Can “impurities” in cola be removed through filtration? The “impurities” I will attempt to filter are the turbidity (the clarity of the cola) and level of acidity and bring the cola back to water (H₂O). How much more acidity can be filtered from different beverages; reverse osmosis or various methods of filtration? Which is better for this study? Research shows that the citric acid and phosphoric acid is in many beverages and is separate from the salt. The acid inside the drink is dissolved, which means the only way to separate the acid is to neutralize the acid.

The research hypothesis is the reverse osmosis process will neutralize the acid in the cola better than filtration straws, water filter, and natural filtration.

The reason I wanted to do this project is because I saw a lot of videos testing out a survival filtration device called “Life Straw”. The Life Straw was shown in the videos to make dirty lake water perfectly clear again (and potable), which made me curious. So, I looked for a GLOBE protocol, and eventually found many different protocols about what I could filter. After researching I concluded that I can test water transparency and pH. Using a natural filter, survival filter, and reverse osmosis, I can test clarity and pH. The beverage I will be using is cola. The reason I chose cola is it will have the most effect on clarity because it is darker than other types of sodas and, therefore, should provide the biggest difference in clarity after filtration. Cola is also well known for having a low pH (we dissolved a nail in cola in elementary school!).

Clean water is better for you, is clear, and has a neutral pH of 7. When I saw videos online about how good the filtration device called Life Straw was, I wanted to see if it would filter out cola. After researching I found out that there is a lot of acid in cola. Therefore, the only

way to take out the acids was to neutralize it. If it is possible to filter out cola, then it must be possible to filter out dirty water from dirty bodies of water, which leads to my hypothesis: reverse osmosis process will neutralize the acid in the cola better than filtration straws and natural filtration. By using different kinds of filters, I can find which one works the best. The filters include a natural filter, Life Straw, Brita filter, and RO.

A study done by Anna Cescon and Jia-Qian Jiang shows how using sand as a natural filter but also says that you can use glass as another layer to prevent debris from entering the clean water because sand is used a lot. Another study by Ying Zhu, Wei Chen, and Xinli Xing states that using ceramic filters takes out microplastics out of bottled water better than polypropylene and washable filters.

The articles I read inspired me to test out different kinds of filters, such as a Brita filter, RO, Life Straw, and a natural filter. The kinds of filters had different ways of filtering. For example, the Brita filter uses a cartridge with activated charcoal and sand like the natural filter. The reverse osmosis chamber utilizes a membrane under pressure to get all of the impurities out of the particle. The Life Straw uses microscopic pores to trap the debris and plastics.

METHODS AND MATERIALS

METHODS:

When designing the experiment, a natural filter, a Life Straw squeeze bottle, Brita filter, and the reverse osmosis process will be used to filter the cola. Turbidity will be tested with a turbidity tube and pH will be tested using pHydrion Lo Ion WR paper test strips to find out which filter purifies the cola the most. My hypothesis is the reverse osmosis process will neutralize the acid in the cola better than the Life Straw, Brita filter, and natural filtration. Therefore, in order to support my hypothesis, the result of pH for reverse osmosis needs to be 7 and the result of turbidity needs to be greater than 100 cm (the maximum limit of the turbidity tube).

CONTROL

- Natural filter
- Cola

VARIABLES

- RO (reverse osmosis) machine
- Life Straw
- Brita filter

MATERIALS:

- Turbidity tube was washed and used to test turbidity.
- Cola was the beverage used to test out different filtration methods.
- One layer of fine sand was dug from Silver Brothers and used in the natural filter.

- One layer of coarse sand was dug from Silver Brothers and used in the natural filter.
- One layer of gravel was dug from Silver Brothers and used in the natural filter.
- Nylon stocking filter was used in the natural filter to cover the top of the bottle.
- Rubber band was used to hold the nylon stocking filter in place.
- RO (reverse osmosis) machine (RO Bucket brand) was used to filter cola.
- Life Straw squeeze bottle purchased from online store was soaked and then was used to filter cola.
- Brita Water Filter was purchased from store to filter cola.

PROCEDURE:

pH TESTS

NATURAL FILTER pH TEST PREPATION:

When building the natural filter, a 2-liter bottle was cut in half and the cap was taken off. Next, a piece of nylon was put over the hole where the cap used to be, then one layer of gravel, one layer of coarse sand, and a layer of fine sand was put in. Lastly, cola was poured into the bottle, and allowed to seep through. The filtered cola was tested for pH with pHDrion Lo Ion WR paper test strips.

LIFE STRAW pH TEST PREPARATION:

When testing the Life Straw for pH, first the cola was poured into the Life Straw water bottle. Next the cola was squeezed out of the bottle. Lastly the pH of cola was tested using pHDrion Lo Ion WR paper test strips.

BRITA pH TEST PREPARATION:

When testing pH with Brita filter, the first step was to fill the water chamber with cola, then let the cola seep through. Lastly take the filtered cola and test the pH with pHDrion Lo Ion WR paper test strips.

REVERSE OSMOSIS pH TEST PREPARTION:

When testing with the Reverse Osmosis (RO), the first step was to process the cola through the RO machine. When the cola was processed, the water from the water bucket was tested for pH with pHDrion Lo Ion WR paper test strips.

TURBIDITY TESTS

NATURAL FILTER TURBIDITY TEST PREPARATION:

When budling the natural filter, a 2-liter bottle was cut in half and the cap was taken off. Next, a piece of nylon was put over the hole where the cap used to be, then one layer of gravel, one layer of coarse sand, and a layer of fine sand was put in. Lastly, cola was poured into the bottle, and allowed to seep through. After filtering, the cola was poured into a turbidity tube and was tested by seeing how much cola is needed to cover up the secchi disk.

LIFE STRAW TURBIDITY TEST PREPATION:

When testing the turbidity with Life Straw, the first step was pouring the cola into the Life Straw water bottle and screwing the cartridge in. After the cola was squeezed out of the bottle and into a turbidity tube where the turbidity was tested by seeing how much cola is needed to cover up the secchi disc.

BRITA FILTER TURBIDITY TEST PREPARATION:

When testing the clarity with Brita filter, the first step was to fill the water chamber with cola, then let the cola seep through. Lastly, take the filtered cola and pour filtered cola into a turbidity tube. The turbidity will be tested by measuring how much cola was needed to cover up the secchi disk.

RO TURBIDITY TEST PREPARATION:

When testing with the reverse osmosis, the first step was to process the cola through the RO machine. When the cola is done processing water taken from the water bucket will be poured into a turbidity tube. The turbidity was tested by measuring how much cola was needed to cover up the secchi disk

Presentation of Data and Results

PLAIN COLA RESULTS (UNFILTERED):

pH

Test 1: pH 4

Test 2: pH 4

Test 3: pH 4

Average: pH 4

Turbidity

Test 1: 2.2 cm

Test 2: 2.3 cm

Test 3: 2.5 cm

Average: 2.38 cm

NATURAL FILTER RESULTS:

pH

Test 1: pH 7

Test 2: pH 6

Test 3: pH 6

Average: pH 6.5

Turbidity

Test 1: 1 cm

Test 2: 1.2 cm

Test 3: 1.1 cm

Average: 1.1

LIFE STRAW RESULTS:

pH

Test 1: pH 4

Test 2: pH 4

Test 3: pH 4

Average: pH 4

Turbidity

Test 1: 3 cm

Test 2: 2.6 cm

Test 3: 2.5 cm

Average: 2.48 cm

BRITA FILTER RESULTS:**pH**

Test 1: pH 4

Test 2: pH 4

Test 3: pH 4

Average: pH 4

Turbidity

Test 1: 7.8 cm

Test 2: 6.5 cm

Test 3: 4.4 cm

Average : 6.2 cm

RO TEST RESULTS:**pH**

Test 1: pH 7

Test 2: pH 7

Test 3: pH 7

Average: pH 7

Turbidity

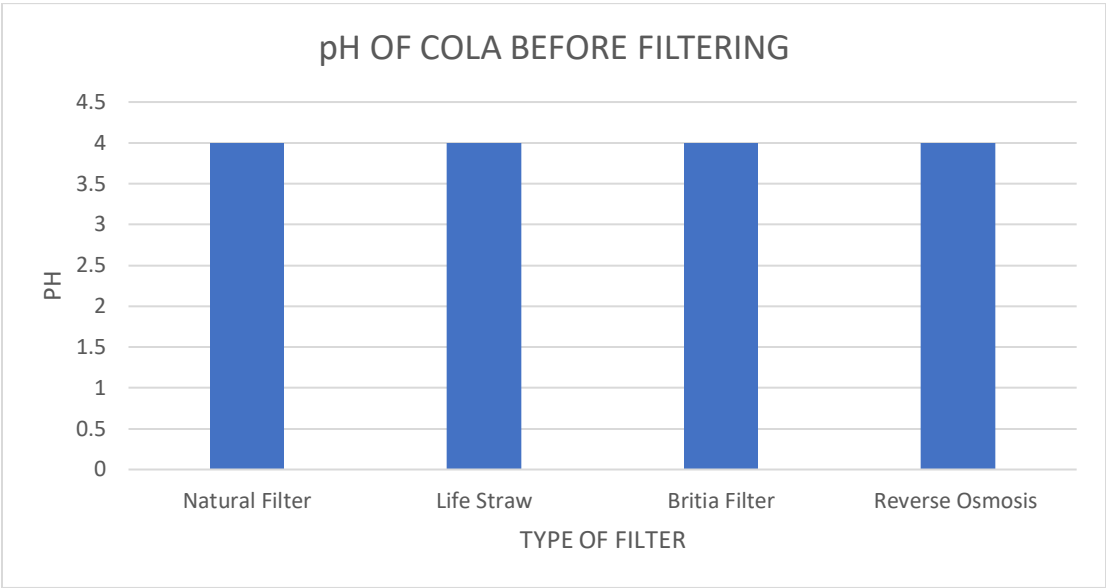
Test 1: < 100 cm

Test 2: < 100 cm

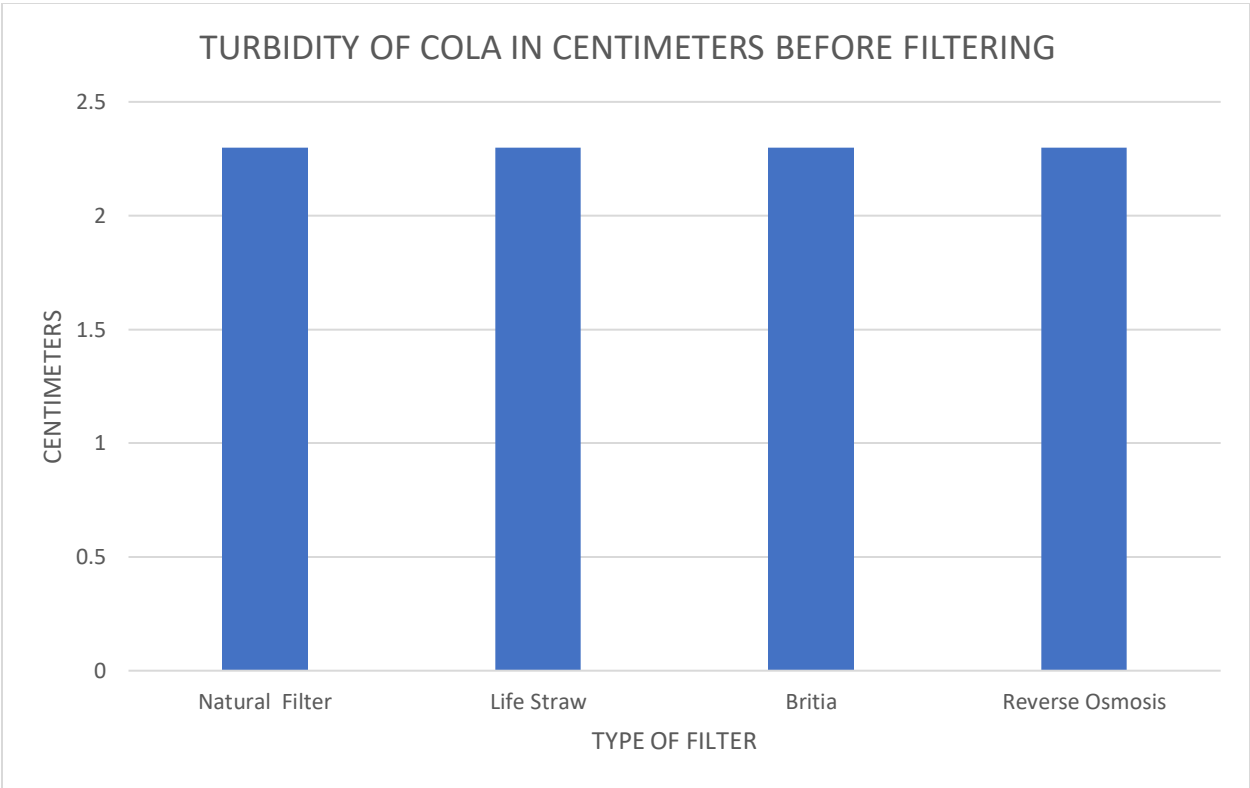
Test 3: < 100 cm

Average: <100 cm

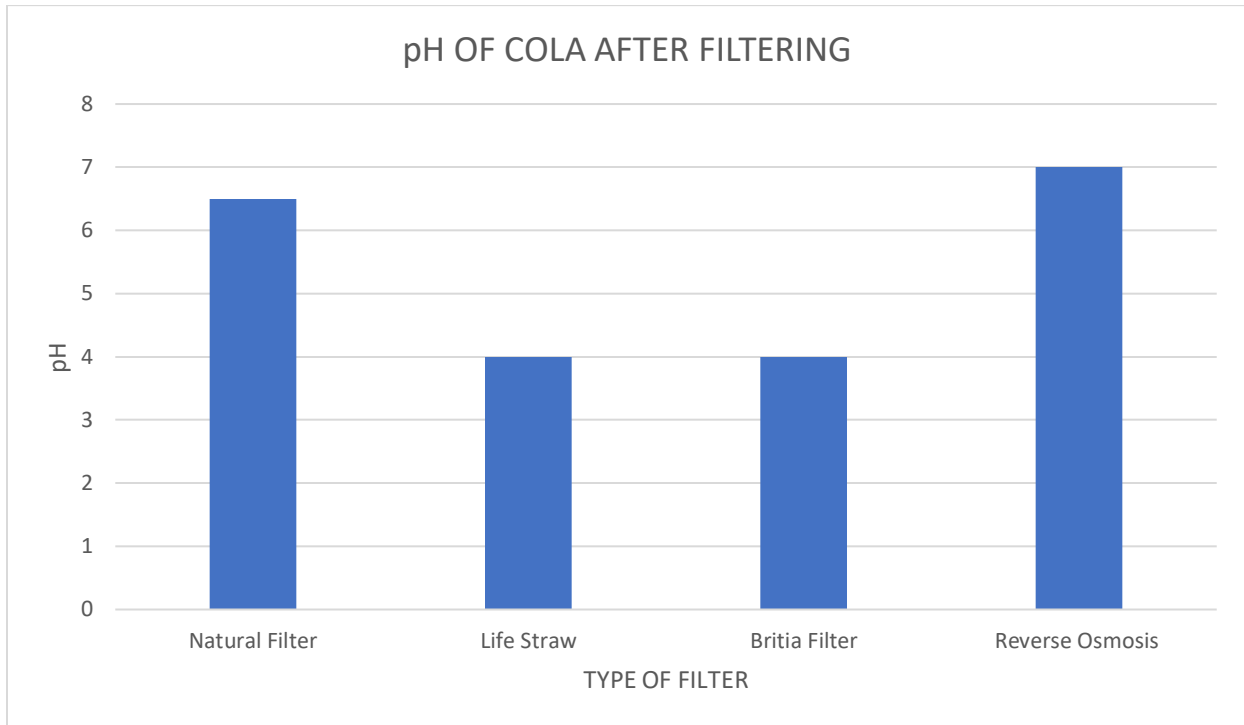
Graph 1.



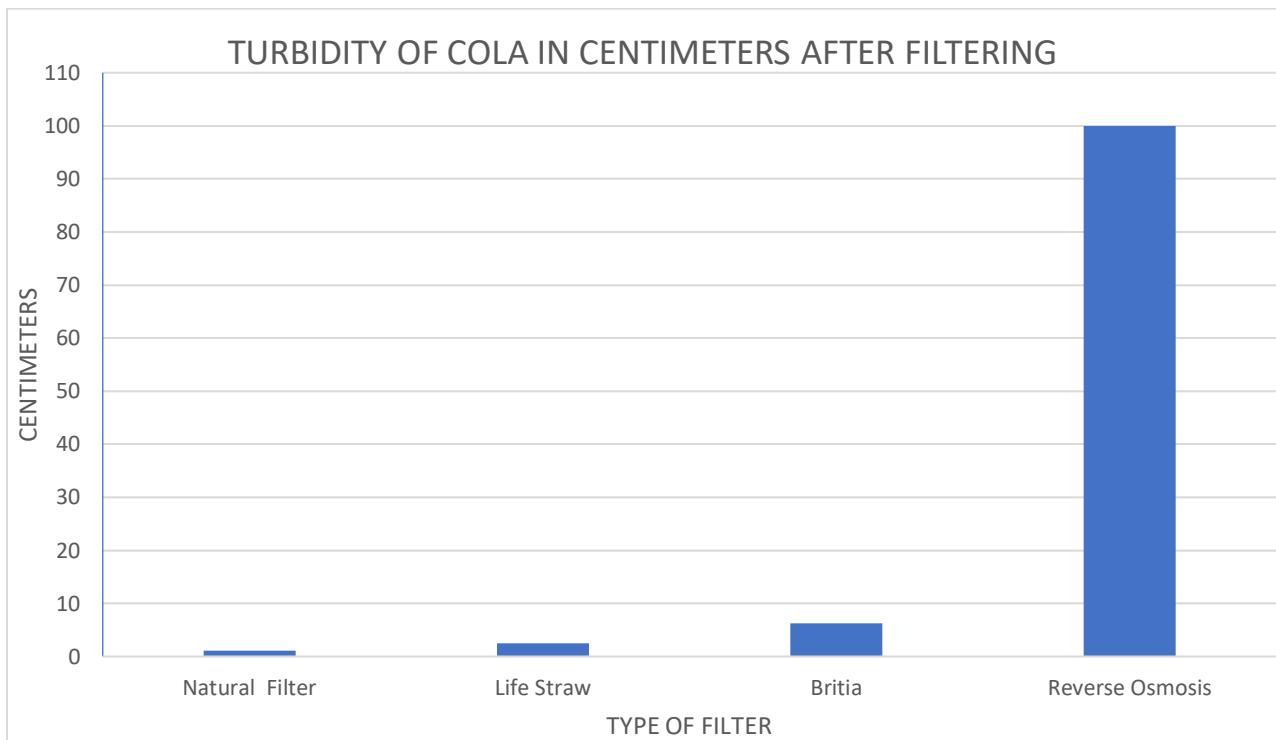
Graph 2.



Graph 3.



Graph4.



Graph one shows the pH value of cola before filtering. The pH value is 4 for all the filtering methods. Graph two shows the turbidity of cola before filtering. The turbidity of cola before filtering is 2.3 cm.

Graph three shows the pH results from all of the filtration methods, and graph four shows the results from testing turbidity of all filtration methods. In graph three, the natural filter surprised me because the pH levels were 6.5 and, the reverse osmosis method had a pH of 7, the Life Straw and the Brita Filter did not do good with a pH of 4. The pH of the original cola was 4, so the natural filter and the reverse osmosis process are the better filters for acidity. The turbidity tests resulted in reverse osmosis being the least turbid and all the others ranging from 1.1 to 2.58 cm.

INTERPRETATION OF RESULTS AND DISCUSSION

In order for the hypothesis to be supported, the cola will need to have a neutral pH of 7 and low turbidity levels.

When testing the natural filter, the pH levels had an average pH of 6.5 and had a high turbidity of 1.1 cm. While natural filtration produced a pH close to neutral, the turbidity actually increased, due to silt filtering through the sand and gravel.

When testing the Life Straw, the pH levels had an average pH of 4 and a high turbidity of 2.48 cm.

When testing the Brita filter, the pH levels had an average pH of 4 and a high turbidity of 6.2 cm.

Both types of man-made filtration did nothing to lower pH or turbidity (Brita lowered turbidity, but ever so slightly).

When testing the RO process, the pH levels had an average pH of 7 and a low turbidity greater than 100 cm. The RO process brought cola pH to neutral and produced water which was crystal clear. However, the RO process is so efficient, it also removes all minerals from the cola, leaving water depleted of any nutritional value.

CONCLUSION

In conclusion, I learned the pH and turbidity of the cola after different kinds of filtering are very similar, and reverse osmosis still gets everything out of the cola to make a natural pH and a turbidity greater than one hundred centimeters. The filtrating methods all had low pH levels of 4 and high turbidity levels of 2 cm, but the natural filter surprised me with pH levels of 6.5 but also had high turbidity levels. Now I had a question: What was making the natural filter work so good compared to expensive man-made filters? After doing some research, I found out natural filters use the cervices in the rocks and sand to “catch” harmful minerals and bacteria in the water. Both sand layers were made up of primarily quartz, which should have little to no effect on neutralizing the acid level of the cola. The rock layer was made up of primarily granite and sandstone (quartz based), once again not having any measurable effect on neutralizing the acid level of the soda. If these layers were made up of, for example, limestone, I would understand lowering the pH from 4 to 6.5. However, this was not the case. In my research, I did not find any definitive reason for the type of sand or rock, except for limestone, which I did not use.

This project was very fun and surprising. I got to test out many different things, and get wet. One thing I had a hard time with was finding a lot of information on Life Straw and Britta

Water Filters. I believe some of this roadblock was because they have company secrets and researching them did become very difficult.

For my next steps I would try to use different natural filters, such as using one with a limestone base. I also think it would be neat to visit perhaps a cave where water has filtered naturally through the Earth. I visited Mammoth Cave when I was little and saw underground streams and pools which I thought were crystal clear. I wasn't thinking about this type of project back then, but I wish I could revisit Mammoth Cave now. And have the opportunity to test the turbidity and pH of their underground streams and pools.

I also believe it would be interesting to test other beverages such as Mountain Dew, orange juice, or sports drinks. Sports drinks, in particular, tend to have a higher salt content (electrolytes). A salinity test would be interesting to use to test if the salt could also be removed through various filtration methods.

This project showed me how reverse osmosis works and how the natural earth filters in the ground work. If I were to recommend filters, a good survival filter is the Life Straw (I haven't tried creek water yet), and a good home filter is the Brita Water Filter.

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