

The Electric Fruits

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Abstract

Electric Fruits

The purpose of this project was to find out which fruit would generate enough electricity to light a light bulb and to discover which fruit would light the bulb the longest. To conduct my experiments I used a Multimeter, copper and zinc wires & electrodes, alligator clips with leads, various light bulbs and five types of fruits.

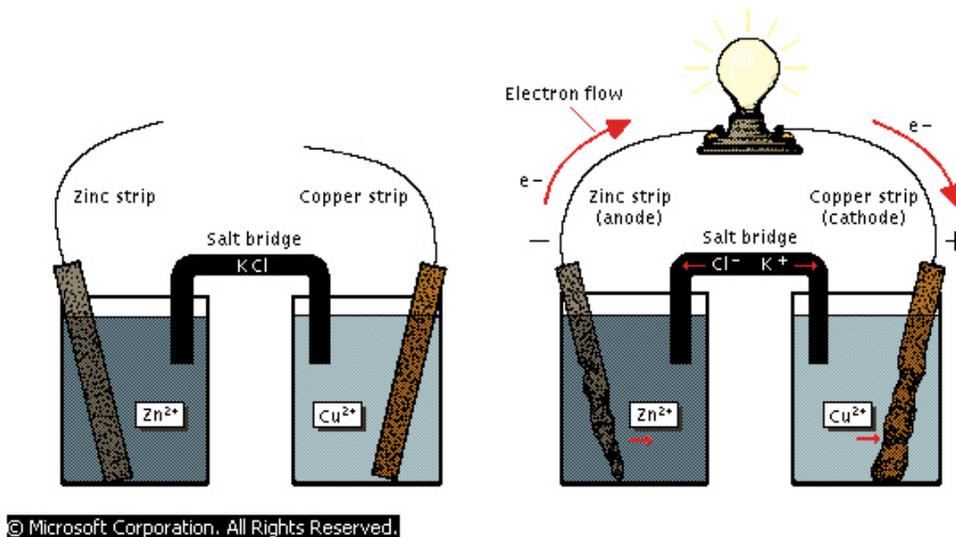
In my experiment, I measured the voltage generated by different fruits. To keep my report unbiased, I did three trials for each fruit then recorded the averages. Next, I connected the alligator clip leads from the fruit to the light bulb and recorded the data.

After several tests, and test refinements still the results were negative. The light bulb would not light up with any of the fruit using any of the variables. I discovered the reason was that the light bulb had too much resistance and the fruit did not produce enough current.

Introduction

Since I am interested in electricity I was very curious to see if you could really light a light bulb with fruit. In my research I have found out that certain fruits contain substances such as ascorbic acid, citric acid and NADH (chemical that generates cellular energy). Under certain circumstances these chemicals act as electrolytes and then undergo electrolysis. Electrolysis means a chemical change produced by electric current passing through an electrolyte. The electrons flow from the cathode through the electrolytes to the anode. The cathode is the negative electrode, which could be the copper wire, and the anode is the positive electrode, which could be the zinc wire. This process generates electricity just the same way as a voltaic battery.

Count Alessandro Volta an Italian physicist, known for his pioneering work in electricity, invented the voltaic battery in 1800. The voltaic pile was a forerunner of the electric battery. The electrical unit known as the volt was named in his honor.



Voltaic Cell: A Chemical Battery

Research

In my research, I have found out that certain fruits contain substances such as ascorbic acid, citric acid, and NADH (a chemical that generates cellular energy). Under certain circumstances these chemicals act as electrolytes and then undergo electrolysis. Electrolysis means a chemical change produced by electric current passing through an electrolyte. The electrons flow from the cathode through the electrolytes to the anode. The cathode is the negative electrode, which could be the copper wire, and the anode is the positive electrode, which could be the zinc wire. This process generates electricity just the same way as a voltaic battery.

Voltage is measured in volts. Voltage is the force or pressure that cause a current to flow in a circuit. A circuit is a path that goes from the positive force to the negative force.

Current is measured in AMPERES (amps.) Copper is a good conductor and has free electrons of the outer ring that fly off constantly. Electrons from atoms near by fill in the holes. There are millions of electrons moving in all directions at the same time. When voltage is applied across a conductor, it drives the free electrons away from the negative force to the positive force. An amp is the number of electrons going past a certain point in one second. To measure current you could use a Voltmeter using the milliamp setting.

Resistance is measured in ohms Ω . Resistance is how well something conducts electricity. The lower resistance in a wire the better it will conduct electricity. Copper has a lower resistance than other metals.

In order to power a light bulb you need both voltage and current.
When you connect fruit in a parallel, it gives you a higher current.
Connect the fruit in a series arrangement it increases the voltage.

Experiment

Purpose

To determine which fruits will generate enough electricity to light a light bulb and to see which fruit will light a bulb the longest.

Materials

3 Sunkist lemons	Wire cutters
3 Texas Rio Star grapefruit	zinc & copper electrodes
3 Hot House tomatoes	alligator clips
3 kiwis	alligator clips with leads
3 California Navel oranges	18-gauge copper wire
1 digital Multimeter (voltmeter)	18-gauge galvanized wire
7.5 watt light bulb	1.5-volt bulb
1. volt flashlight bulb	1.5-volt lamp
bulb holders for various sizes of bulbs	Wire cutters
stopwatch	

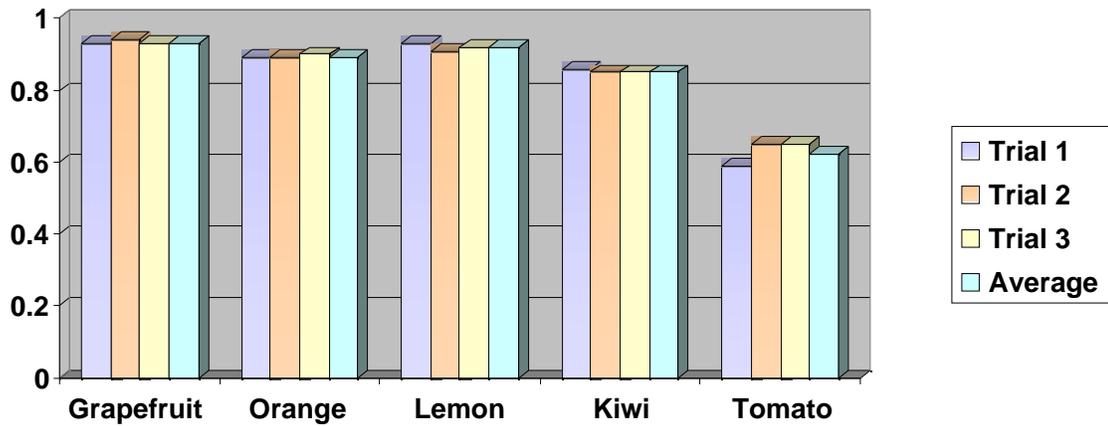
Procedure

1. Insert a 2-1/2cm piece of galvanized wire and a 2-1/2cm piece of copper wire into each piece of fruit. Connect the leads on the Multimeter to each wire. Measure the voltage and record the scores. Do three times for each fruit and determine the average score, record this data.
2. Disconnect the Multimeter and connect alligator clips with leads.
3. Connect leads to the light bulb holder, insert light bulb.
4. Record the results. If the bulb lights up, also record how long the bulb stays lit.
5. If bulb does not light up, string more fruit cells together attaching copper to zinc on each fruit.
6. Record the results of each fruit.
7. If results are negative replace the copper and galvanized wire with the copper and zinc electrodes.
8. Record the results.

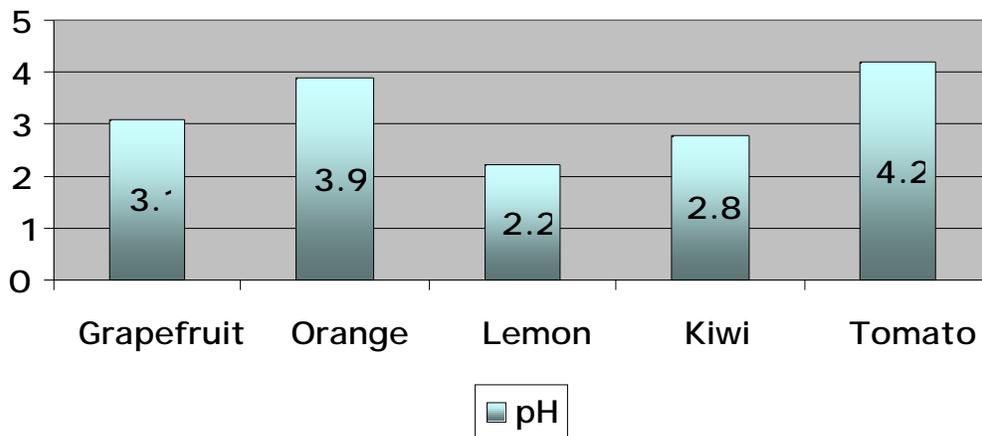
Graphs

Average Fruit Voltage

	Grapefruit	Orange	Lemon	Kiwi	Tomato
Trial 1	.93	.89	.93	.86	.59
Trial 2	.94	.89	.91	.85	.65
Trial 3	.93	.90	.92	.85	.65
Average	.93	.89	.92	.85	.62



Approximate pH Le



Conclusion

From December 16th through December 31st I conducted many tests making refinements as needed. At first, I was unable to accurately measure the voltage of the fruits. I learned why the Multimeter would not give a steady reading. It was due to a bad connection. At this point, I replaced the galvanized and copper wires with zinc and copper electrodes. I was now able to obtain accurate readings. However, the light bulb still would not light up. I strung three lemons together and still they would not produce enough current to light the bulb. Further research confirmed that lemons or other fruit could not produce enough current to light a light bulb. A Chemistry Professor in Tennessee confirmed I was conducting my experiment correctly but it would not work because light bulbs have too much resistance. Resistance is when electrons collide into atoms in the conductor. The current is reduced and therefore the light bulb will not light.

My hypothesis stated that grapefruit would light the bulb the longest since it was the largest of all my fruits as it might contain the most citric acid. Although none of the fruits lit up the light bulb and my hypothesis was incorrect, the grapefruit did have the highest average voltage of my tested fruits.

If I did this project, again I would use an LED light, clock, or calculator instead a light bulb. Another thing I could try would be to compare vegetables to fruits. Fruit produces a small amount of current, not enough to light up a light bulb, even with multiple fruits attached together. Vegetables, especially potatoes, may have a higher current than fruit.

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Acknowledgments

I would like to thank Daniel J. Swartling of the Department of Chemistry, Tennessee Technological University in Cookeville Tennessee for the information contained in his websites and his personal assistance on my project. He explained why my project would not work using light bulbs.

Throughout my project, I had been given so much wrong information from different sources and from some Internet sites. We e-mailed several people asking for assistance when the project “failed.” One was “Dr. Dan,” another person did also answer but he was not able to help on this project, two people did not answer at all. “Dr. Dan” was quick in replying, informative, kind and helpful when I needed help the most. He told me “there is no such thing as obtaining bad results from an experiment, only results that you did not wish to obtain.” That made me feel better knowing that I did not “fail” and that I did not do anything wrong in my experiments.

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I also want to thank Susanne Garfield-Jones, Media and Communications Office of the California Energy Commission. She gave me reassurance that I did my project right, but there was not enough current to light the bulb. She reminded me that part of the science fair project is learning the scientific process, which I have done. Ms. Garfield-Jones told me “the point of this experiment is to show that acidic foods can chemically generate an electric current (which you have shown with the meter) to mimic a battery.” She also indicated “What doesn’t work and why is as important as what does work. A successful project is one that the scientist has kept good records of his or her attempts to prove their hypothesis, clear and understandable results and an understanding of the scientific concepts behind their hypothesis.”

<http://www.energy.ca.gov/education>