



**Highly Commended**

# **Science Investigation**

## **Year 3 - 4**

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**Goodwood Primary School**



## Science investigation: What Fruit or Vegetable Makes the Best Battery?

Evie Williams

### Introduction

Electricity powers so much of what we use in the world today. Batteries store electricity which power many of our favorite technology and devices including light bulbs, tablets and phones. As someone who loves technology but also interested in environmentally friendly power sources, I am interested in why fruit and vegetables can be used to make a battery and which fruit or vegetable would make the best battery. The question I want to answer with this investigation is if we made a battery with a fruit or vegetable, which one would produce the most electricity. My prediction is that juicy or citrus fruits will produce the highest voltage.

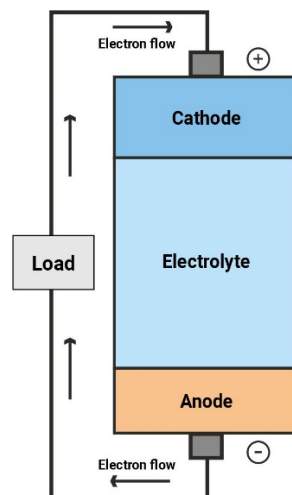
### Research

In order to investigate this question, we first have to understand how a battery works. A battery is like a lunch box full of power. It stores chemical energy and turns it into electrical energy. It lets us use devices without being plugged into a wall. There are three main parts to a battery:

1. The negative side which is called the Anode
2. The positive side which is called the Cathode
3. The liquid in the middle of the Anode and the Cathode which is called the Electrolyte

A battery produces an electric current because electrons from the negative side (Anode) travel through the liquid in the middle (Electrolyte) to the positive side (Cathode).

Figure 1



We can use something made from a metal called zinc for the Anode because zinc reacts with the Electrolyte and causes electrons to escape from the Anode. We can use something made from a metal called copper for the Cathode because the copper becomes positively charged in the Electrolyte and attracts electrons. The flow of electrons between the zinc and copper creates an electric current.

Fruit and vegetables can act as the Electrolyte because they contain chemicals called acid that react with the metal and loosen electrons so they can escape. Fruits such as lemons and passionfruit have lots of acid in their juice, therefore I predict juicy or citrus fruits will produce the highest voltage.

## Predictions

1. Juicy or citrus fruits will conduct higher electric voltage.
2. The lemons that grow in my garden will conduct a higher electric voltage than the lemons purchased from Woolies, because my home-grown lemons are juicier.

## Equipment and material

The equipment and material below are used to conduct the experiment:

1. Digital multimeter
2. Zinc plated screws
3. Copper wire
4. Paper towel
5. Assortment of fruits and vegetables
6. Scissors

Figure 2 – Multimeter, copper wire, zinc screws and fruit/vegetables



## Experiment

The steps below show how to conduct the investigation:

1. Stab a zinc screw and a copper wire into each fruit and vegetable.
2. Ensure the copper wire and the zinc screw are a similar distance apart in each fruit and vegetable.
3. Connect the red wire (positive end) of the multimeter to the copper wire and connect the black wire (negative end) of the multimeter to the zinc screw.
4. Record the voltage readings on the multimeter for each fruit and vegetable.

The risks I identified in carrying out this experiment were the use of sharp objects such as the zinc screws and copper wire, and exposure to voltages. See Risk Assessment form for how the risks were controlled.

Figure 3 – Testing voltage produced by an orange, grape and potato



### Variables

| Variables to control                                       | How to control them                                                                                                                                       |
|------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Anode (zinc screw) and the Cathode (copper wire)           | Use the same zinc screw and same copper wire for each fruit and vegetable tested.<br><br>Using different ones may produce different voltages.             |
| Distance between the Anode (zinc) and the Cathode (copper) | The distance between the electrodes and how they are inserted in the fruit and vegetables should be consistent.<br><br>If not, it may impact the voltage. |

The variable I measured in my experiment is the electric voltage produced by each fruit and vegetable (variable changed).

### Results

Table 1 - Ranking by voltage of 10 fruits and vegetables

| Fruit/vegetable | Rank (predicted) | Voltage tested (V) | Rank (tested) |
|-----------------|------------------|--------------------|---------------|
| Lemon           | 3                | 0.82               | 9             |
| Passionfruit    | 1                | 0.84               | 8             |
| Capsicum        | 10               | 0.83               | 6             |
| Potato          | 8                | 0.87               | 5             |
| Tomato          | 5                | 0.88               | 3             |
| Kiwi            | 4                | 0.87               | 5             |
| Sweet potato    | 9                | 0.92               | 2             |
| Orange          | 2                | 0.84               | 8             |
| Apple           | 7                | 1.01               | 1             |
| Grapes          | 6                | 0.77               | 10            |

Table 2 – Voltage of home-grown lemons compared to Woolies lemons

| Lemon          | Woolies lemons (V) | Home grown lemons (V) |
|----------------|--------------------|-----------------------|
| Lemon 1        | 0.83               | 0.82                  |
| Lemon 2        | 0.86               | 0.84                  |
| Lemon 3        | 0.83               | 0.84                  |
| Lemon 4        | 0.81               | 0.87                  |
| Lemon 5        | 0.81               | 0.83                  |
| <b>AVERAGE</b> | <b>0.83</b>        | <b>0.84</b>           |

### Evaluation

The results of my experiment were surprising. The apple produced the highest voltage (1.01V), followed by the sweet potato and then the tomato. I had expected the juicier fruits or citrus fruits to do the best, but passionfruit and lemon were only eight and ninth place. I predicted capsicum would give the lowest voltage, but it tested in sixth place.

The results of my second investigation were less surprising. The home-grown lemons produced a higher voltage on average than the lemons from Woolies. However, results were closer than I thought it would be. The home-grown lemons produced an average voltage of 0.84V and the Woolies lemons produced slightly less with an average of 0.83V.

Chart 1 – Voltage tested by fruit/vegetable

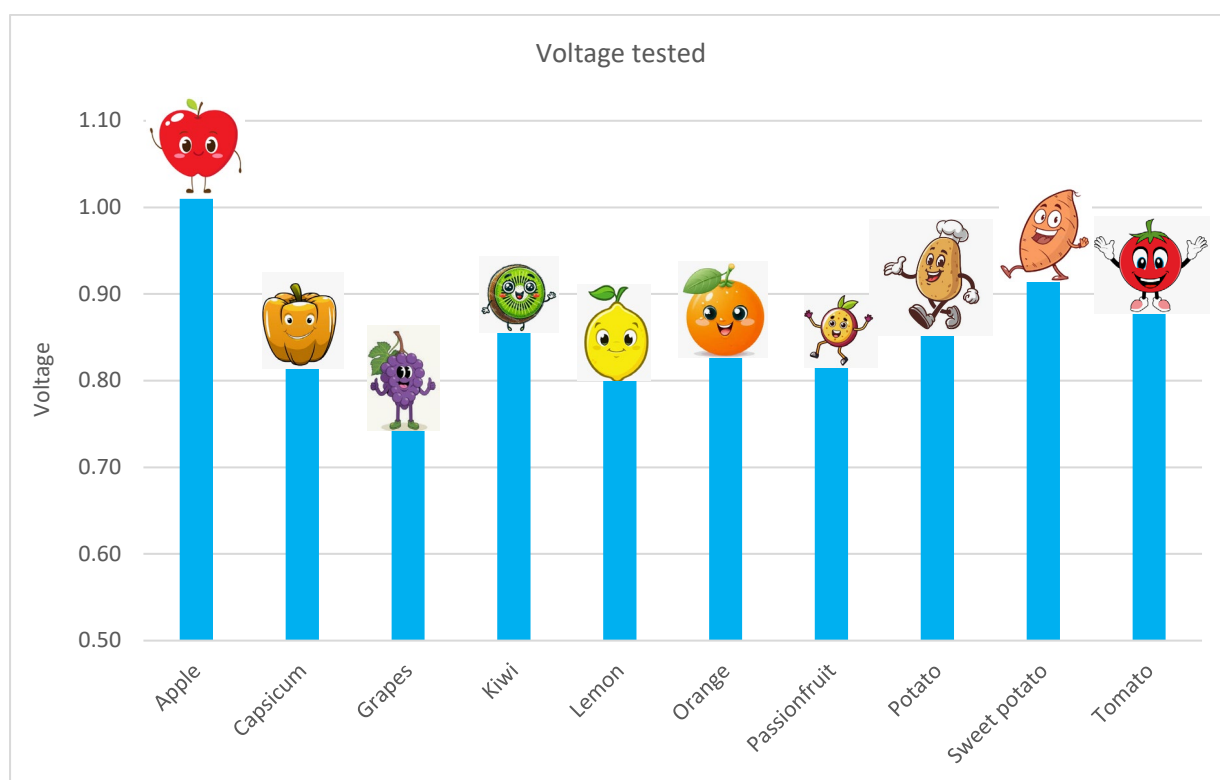
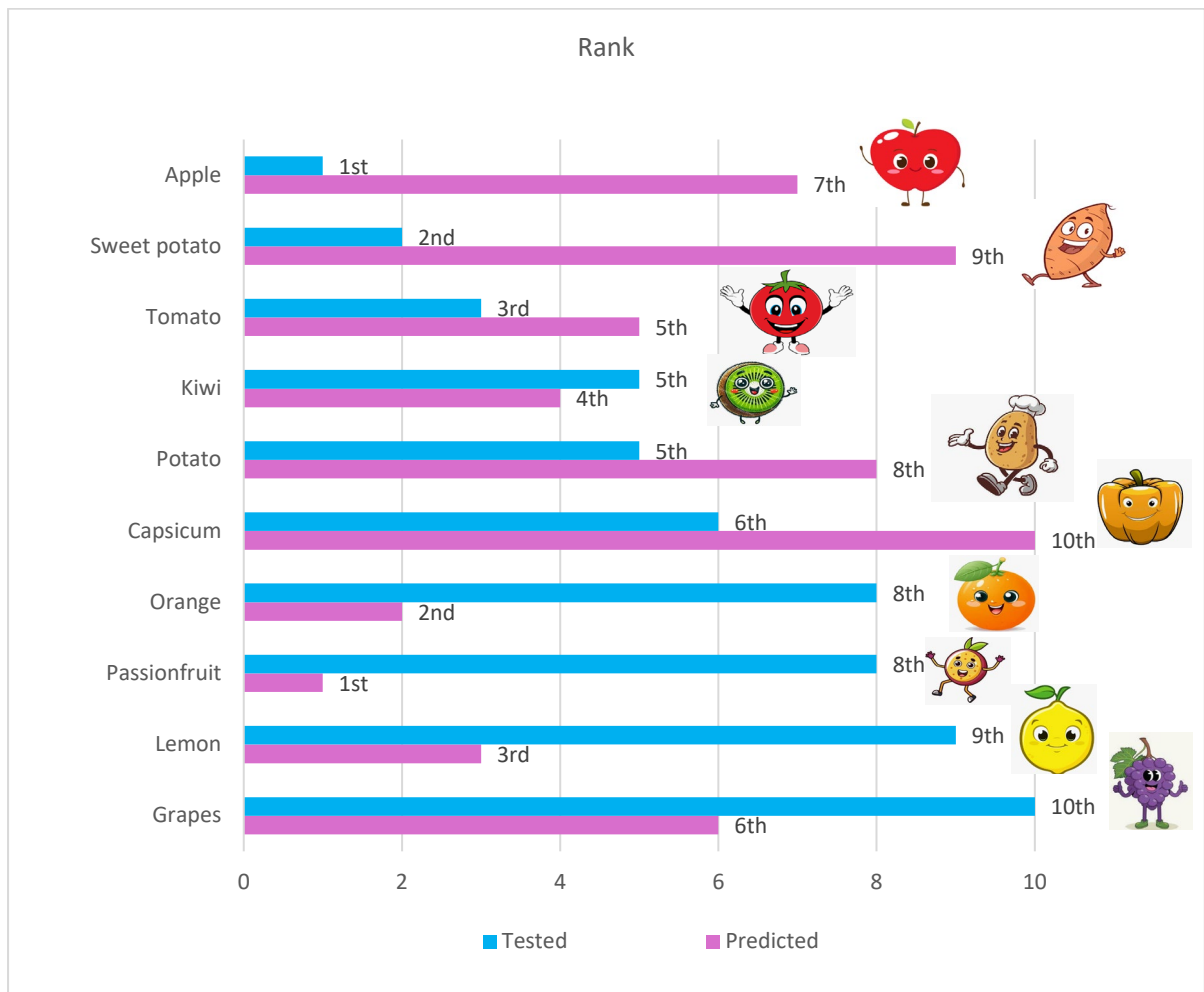
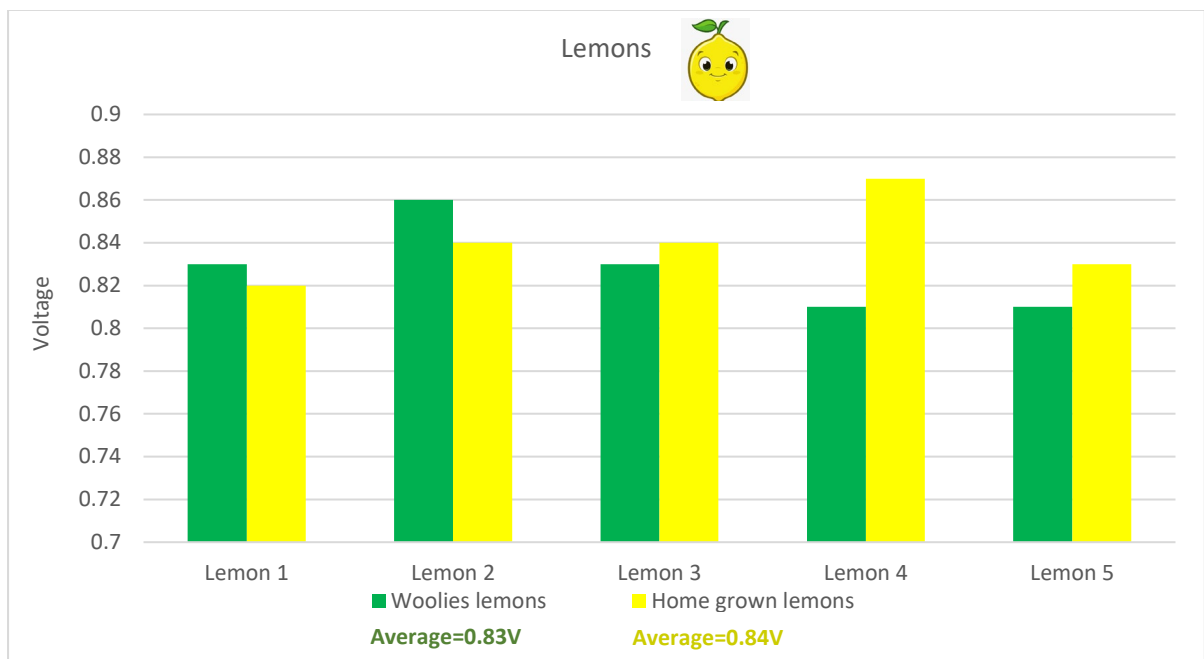


Chart 2 – Predicted rank by voltage compared to tested rank by voltageChart 3 – Voltage produced by five home grown lemons and five Woolies lemons

## Conclusion

In conclusion, it was not the juicy or citrus fruits that produced the highest voltage. This is because while we think of fruits like lemons and passionfruit as having lots of acidic juices because of how they taste to us, other fruits and vegetables like potatoes are juicy and contain lots of acid in. It is just a different type of acid which tastes different to us.

The home-grown lemons produced a slightly higher voltage on average than the Woolies lemons, although the results were very close. In order to form stronger conclusions for this test, it would be good to know what variety of lemon grows in my garden compared to the lemons we purchased from Woolies. Different types of lemons may produce a different electric voltage and therefore to make the test fairer the same type of lemons need to be compared.

A good next investigation to complete would be to connect more than one fruit and vegetable together to produce a higher voltage to see what electrical devices we could power with fruit and vegetables alone. This would require some additional equipment and further safety considerations given we would be experimenting with higher voltages.

## References

BBC Bitesize - Batteries

[www.bbc.co.uk/bitesize/articles/zx4shcw#zw2k8hv](http://www.bbc.co.uk/bitesize/articles/zx4shcw#zw2k8hv)

Energy Kids (US Energy Administration)

[www.eia.gov/kids/energy-sources/electricity/science-of-electricity.php](http://www.eia.gov/kids/energy-sources/electricity/science-of-electricity.php)

Science World - Lemon Battery

[www.scienceworld.ca/resource/lemon-battery/](http://www.scienceworld.ca/resource/lemon-battery/)

The European Battery Business Club - Materials for a fruit battery

[www.batterybusinessclub.com/materials-for-a-fruit-battery/](http://www.batterybusinessclub.com/materials-for-a-fruit-battery/)

Let's Talk Science - How does a lithium-Ion battery work?

[www.letstalkscience.ca/educational-resources/stem-explained/how-does-a-lithium-ion-battery-work](http://www.letstalkscience.ca/educational-resources/stem-explained/how-does-a-lithium-ion-battery-work)

### Logbook

| Date           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>30 May</b>  | I would like to investigate something to do with electricity or magnets as I am fascinated by it. I have researched that electricity and magnetic fields are all around us. We use electricity for so many things. I can hardly imagine the world without it. It is so important to how we live.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>31 May</b>  | I saw an experiment on the internet where someone made a battery using a lemon. It got me thinking about how batteries work and how they produce electricity. It also got me thinking which fruit or vegetable would make the best battery.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>2 June</b>  | <p>I researched several sources to better understand how batteries work and how a fruit or vegetable can be used to make a home-made battery. The sources I used to research were</p> <ul style="list-style-type: none"> <li>• BBC Bitesize – Batteries (<a href="http://www.bbc.co.uk/bitesize/articles/zx4shcw#zw2k8hv">www.bbc.co.uk/bitesize/articles/zx4shcw#zw2k8hv</a>)</li> <li>• Energy Kids US Energy Administration (<a href="http://www.eia.gov/kids/energy-sources/electricity/science-of-electricity.php">www.eia.gov/kids/energy-sources/electricity/science-of-electricity.php</a>)</li> <li>• Science World - Lemon Battery (<a href="http://www.scienceworld.ca/resource/lemon-battery/">www.scienceworld.ca/resource/lemon-battery/</a>)</li> <li>• The European Battery Business Club - Materials for a fruit battery (<a href="http://www.batterybusinessclub.com/materials-for-a-fruit-battery/">www.batterybusinessclub.com/materials-for-a-fruit-battery/</a>)</li> <li>• Let's Talk Science - How does a lithium-Ion battery work? (<a href="http://www.letstalkscience.ca/educational-resources/stem-explained/how-does-a-lithium-ion-battery-work">www.letstalkscience.ca/educational-resources/stem-explained/how-does-a-lithium-ion-battery-work</a>)</li> </ul> |
| <b>6 June</b>  | I went with my dad to Bunnings to buy equipment for my experiment. We bought copper wire. That is all we needed as it turned out my dad already had zinc plated screws in his toolbox in the shed and he also has a multimeter to measure voltage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>7 June</b>  | My dad and I created the Cathode by cutting some copper wire and bending it into shape. We tested it on a lemon with a zinc screw as the Anode and it worked – we were able to measure voltage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>20 June</b> | <p>My dad and I went to Woolies and purchased 5 lemons, a sweet potato, a potato, a passionfruit, a potato, a capsicum and a tomato. We already had oranges, kiwi and grapes in the house. I also picked 5 home grown lemons from the lemon tree in my garden.</p> <p>I performed the experiment together and recorded all the voltage measures that same day under my dad's supervision. I recorded all results – see Table 1 and Table 2 in my report.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

## Risk assessment form

## OSA RISK ASSESSMENT FORM

for all entries in ☒ Models & Inventions and ☒ Scientific Inquiry

This must be included with your report, logbook or entry. One form per entry.

STUDENT(S) NAME: Evie Williams ID: 0215-014SCHOOL: Goodwood Primary School

Activity: Give a brief outline of what you are planning to do.

To test the voltage produced by different fruits and vegetables, I will insert a zinc screw and a copper wire into each and measure the voltage with a multimeter. I will compare results to see if juicier fruits/vegetables generate more voltage and whether home-grown lemons produce higher voltage than store-bought.

Are there possible risks? Consider the following:

- Chemical risks: Are you using chemicals? If so, check with your teacher that any chemicals to be used are on the approved list for schools. Check the safety requirements for their use, such as eye protection and eyewash facilities, availability of running water, use of gloves, a well-ventilated area or fume cupboard.
- Thermal risks: Are you heating things? Could you be burnt?
- Biological risks: Are you working with micro-organisms such as mould and bacteria?
- Sharps risks: Are you cutting things, and is there a risk of injury from sharp objects?
- Electrical risks: Are you using mains (240 volt) electricity? How will you make sure that this is safe? Could you use a battery instead? \*Only batteries can be used for Models & Inventions entries
- Radiation risks: Does your entry use potentially harmful radiation such as UV or lasers?
- Other hazards.

Also, if you are using other people as subjects in an investigation you must get them to sign a note consenting to be part of your experiment.

| Risks                                                                                                                              | How I will control / manage the risk                                                                                                                                                                                                              |
|------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inserting sharp zinc screws and copper wires into fruits/vegetables could cause cuts or puncture injuries.<br>Exposure to voltage: | I asked my parents to help, and made sure that the fruits and vegetables were held securely in place while the screws and wires were inserted.<br>• I made sure there was a clear working space and I got my dad to supervise my spare experiment |

(Attach another sheet if needed.)

Risk Assessment indicates that this activity can be safely carried out

RISK ASSESSMENT COMPLETED BY (student name(s)): \_\_\_\_\_

Evie WilliamsSIGNATURE(S): Evie☒ By ticking this box, I/we state that my/our project adheres to the listed criteria for this Category.TEACHER'S NAME: Kellie MensforthSIGNATURE: [Signature] DATE: 26/6/26