

LESSON PLAN ON FRUIT AND POTATO BATTERY: HOW TO UTILIZE THE CHEMICAL POTENTIAL ENERGY IN FOODS

BACKGROUND

Batteries are containers that store the chemical energy from foods and other sources, which can be converted to electrical energy or what we call electricity. They depend on an electrochemical reaction to do this. Batteries can generate electricity through the chemical reaction in foods, acids and liquid conductors (known as electrolytes) by using two different electrodes (zinc and copper electrodes) connected across the source of an electrolyte. For example, as in the case of sulfuric acid as an electrolyte is a proven method for this method.

The question here is; can we make use of other liquid electrolyte? Yes, we can. There are many other liquid electrolyte that can generate electricity such as potato, lemon, grape fruit and so on.

In this study we shall compare electricity generation potential of potato juice and citrus fruits (e.g., lemon, lime, orange, grape fruit). We are experimenting on potato and lemon in this study but any of the citrus fruits mention above can also work well.

HOW THEN CAN THESE JUICES BE USED TO GENERATE ELECTRICITY?

Fresh juices from potato, lemon or grape fruit contains many water soluble chemicals that will cause a chemical reaction with one or both of the electrodes and serve the purpose of an electrolyte. So we may get some electricity from that.

TIME ALLOWED: 90 minutes

CLASS OUTCOME: At the end of this lesson, students should be able to;

- ✚ Identify that energy can be produced from chemical sources
- ✚ Understand that energy can be converted from one form to another
- ✚ Explain how chemical energy can be converted to electrical energy
- ✚ Identify that different chemical energy sources have different electrical energy capability
- ✚ Determine which of the fruit batteries produces the highest voltage

MATERIALS:

- ✚ Copper nail (copper electrode)
- ✚ Galvanized nail (zinc electrode, can be brought from electrical material store)
- ✚ Citrus fruits and potato
- ✚ Alligator clips
- ✚ Voltmeter (digital or analog)
- ✚ LED bulbs

INTRODUCTION (10 minutes)

Can you imagine what life would have been without batteries? If not for this handy way of storing electrical energy, we would not be able to have all of our portable electronic devices, such as phones, tablets and laptop computers. So many other items from remote-control cars to flashlights to hearing aids would also need to be plugged into a wall outlet in order to function.

Ask the students the following questions to get them thinking?

- ✚ Why do we need battery? Comment: to store voltage which can be used in the absence of direct power supply
- ✚ What are batteries made of? Comment: chemical cells
- ✚ What type of battery do we have? Comment: rechargeable and non-rechargeable batteries
- ✚ How can you make a battery from chemical sources such as an acid? Comment: by connecting two different electrodes to an electrolyte (acid conductor in this case)
- ✚ Can battery be then made from fruits and vegetables? Comment: yes
- ✚ How can this be achieved? Comment: you shall find out in this lesson

HOW DOES IT WORK?

Batteries are comprised of two different metals suspended in an acidic solution. Here, the two metals are zinc and copper while the acid comes from either the citric acid inside any of the fruits or the phenolic acid inside the potato.

The two metal components are called electrodes, they are the parts of a battery through which electrical current enters and leaves the battery. With a zinc and copper setup, the electron flow is out of the copper nail (a penny could also be used) and into the zinc nail through the acidic juice inside the lemon or the potato. In the exchange of electrons between the zinc and the copper over the acid bridge, copper accepts two electrons from zinc which accounts for the current.

The circuit is completed once the fruit power battery is connected to an LED. Note that an LED is polar sensitive which means an LED will glow only if the current is flowing through it in the right direction. If you hook up the LED and it doesn't glow, switch the alligator clips attached to its legs. That should do it.

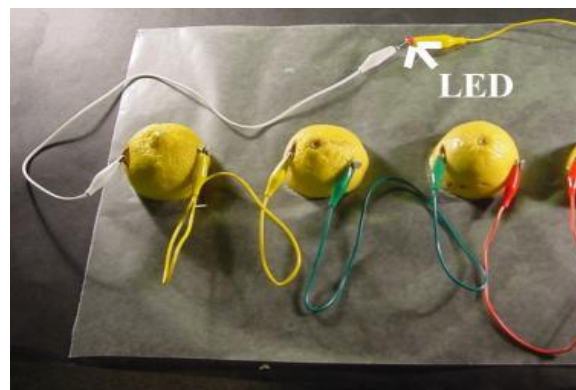
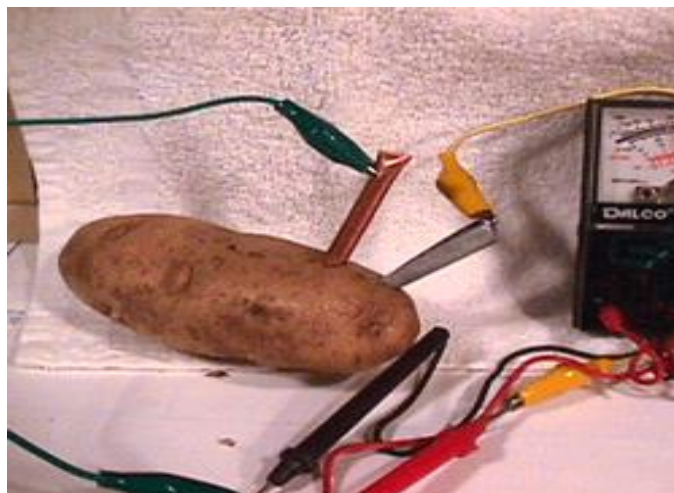
Use the voltmeter to determine the amount of power that can be obtained from these foods.

ACTIVITY (40 minutes):

Experimenting with a potato: Push the zinc and copper electrode into one potato, connect alligator clip to the end of the zinc and copper electrodes and connect the other ends of the alligator clip to a voltmeter and record the reading, then connect the ends of the alligator clip to a LED bulb. Does it light up the LED bulb?

Experimenting with lemon: Connect in the same way using lemon

Note, two or more of the foods can be connected in series to get a higher voltage reading. A series connection is demonstrated as shown in image 3.



DISCUSSION (10 minutes):

Citrus fruits have an acidic content likewise vegetables such as potato, and the more acidic it is, the better it is for conducting electricity. This is the reason why even though the nails were not touching each other, your fruit battery still worked! The fruit contains positively charged ions.

When you inserted the galvanized or zinc nail into the fruit, the negatively charged ions or the electrons started to move from the fruit to the zinc nail thus leaving the protons in the fruit. This transfer of electrons generates electricity as soon as you attach the wires to the nail, and the bulb lights up! Amazing huh?

What do the students think of this lesson? What other materials could they use to experiment? How well do they understand the principles of electrochemical cell conversion? Get their feedbacks on the lesson plan.

GAMES (10 minutes)

Play games to help the students relax and absorb what has been learnt. Games could be in form of a revision by throwing balls around and gradually list the material and methods use in the lesson in turns as the ball gets to you. Just find something interesting to do with the students

GROUP PROJECT (15 minutes)

Group students into groups of five and provide them with different materials to build a battery and determine the voltage reading. They could also combine the different fruits to determine if it works well together and if it gives a higher voltage or not.

CLOSING REMARKS AND EVALUATION (5 minutes):

Record students' achievements on this lesson plan and encourage them to try out some more fruits and vegetables at home which will be discussed in the meeting.



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