

Food Battery

Description: This demonstration shows that some foods contain electrolytes which can be used to construct a galvanic cell.

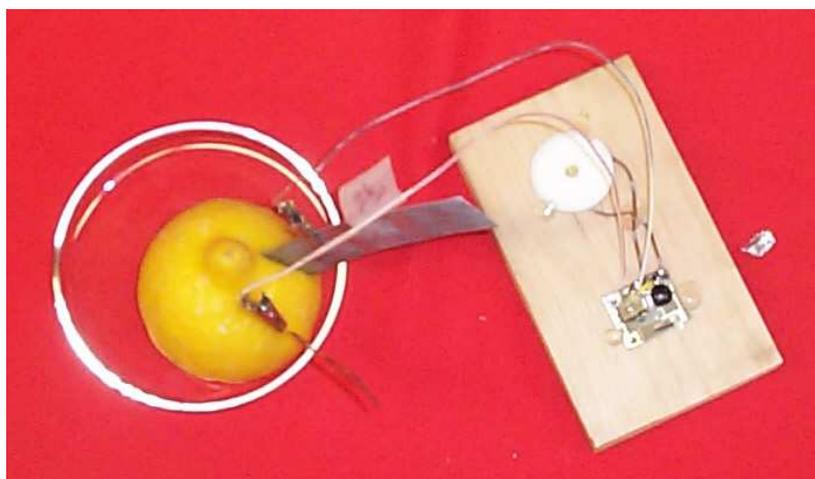
Materials:

Metal electrodes (Zn, Cu, Fe, Al, Sn)	Voltmeter
Food (lemon, orange, potato)	Connecting wires
	Alligator clips

Procedure:

For large lecture halls, project demonstration using a document camera.

1. Cut two small slits on either side of the food being used (works best with lemon). Insert the electrodes to be tested. To stay within the theme of using household items, a penny can be used for the copper electrode while a “silver” coin or galvanized nail works best for a zinc electrode.
2. Connect electrodes to voltmeter to register a voltage for the generated battery. Using different electrode materials demonstrates the differences in reduction potentials for various metals, listed below.
3. A series of cells can be constructed by using multiple lemons (or other food item) and connecting the cathode on one to the anode on the other. If enough of the foods are connected together, a voltage large enough to power an electronic device can be produced (illuminate an LED, power a wrist watch or alarm clock, etc.).



Discussion:

In this cell the fruit serves as an acidic electrolyte medium for the redox process to take place in although the fruit can serve as an electrode itself (as demonstrated in the Shakhashiri reference).

Reduction Potentials (vs. SHE)	E°_{red} (V)
$\text{Al}^{3+} + 3 \text{e}^{-1} \rightarrow \text{Al}$	- 1.66
$\text{Zn}^{2+} + 2 \text{e}^{-1} \rightarrow \text{Zn}$	- 0.76
$\text{Fe}^{2+} + 2 \text{e}^{-1} \rightarrow \text{Fe}$	- 0.44
$\text{Sn}^{2+} + 2 \text{e}^{-1} \rightarrow \text{Sn}$	- 0.14
$\text{Cu}^{2+} + 2 \text{e}^{-1} \rightarrow \text{Cu}$	+ 0.34

Safety: Care should be taken to not get food juices in the eyes as this may cause severe discomfort.

Disposal: Electrodes should be rinsed, dried and cleaned by scrubbing with steel wool.

References:

Shakhashiri, B. Z. In *Chemical Demonstrations: A Handbook for Teachers of Chemistry*; The University of Wisconsin Press: 1992; Vol. 4, p 107-110. (a variation of this demonstration)

http://hilaroad.com/camp/projects/lemon/lemon_battery.html

Video:

<http://www.youtube.com/watch?v=AY9qcDCFeVI&feature=fvw> (long but thorough video)

<http://www.youtube.com/watch?v=ax3iMxqu3ks&feature=channel>