



## Lesson 4

# Biodegradable ink

**Time:** 45 min. class period

### HCPS III Science Benchmarks

**SC.6.6.6** Describe and compare the physical and chemical properties of different substances

**SC.6.1.2** Use appropriate tools, equipment, and techniques safely to collect, display, and analyze data

**SC.6.2.1** Explain how technology has an impact on society and science

**SC.6.2.2** Explain how needs of society have influenced development and use of technologies

**SC.7.2.1** Explain the use of reliable print and electronic sources to provide scientific information and evidence

**SC.8.2.1** Describe the significant relationships among society, science, and technology and how one impacts the other

### NSES standards

Form and function

Populations, resources, and environments

Risks and benefits

Science and technology in society

Science as human endeavor

### Learning Objectives

Sloss, Watters, School Garden Curriculum

1. Students will use appropriate tools to collect materials and create their own biodegradable ink and method for printing on paper
2. Students will describe and compare the physical and chemical properties of at least three types of inks
3. Students will write 2 advantages and 2 disadvantages of using 2 different inks

### Background info

**Why does ink matter? Inks** existed in ancient cultures including China at least as far back as the 18<sup>th</sup> century BC. Ingredients used included animal glue, made from boiled animal cartilage, soot, plant dyes, plant oils, and ground graphite. Hawaiians made oil based dyes for painting from charcoal and kukui oil. They also made water based dyes from various plants such as hau, uki uki, and olena.

Today many inks are petroleum based which raises a number of environmental as well as economical concerns. Plant based ink, such as from soy, is said to be more environmentally friendly for several different reasons. First off when paper is recycled it must first be deinked. Soy based ink is easier



to remove that petroleum based ink This means that the recycled paper will have less damage to its fibers giving it a brighter appearance. Also the waste that is left from the soy ink after removal is not hazardous and it can be treated easily. In addition soy ink reduces our dependence on petroleum as a source for oil. Petroleum production is plagued with harmful chemicals that leach into the environment from extraction, to transportation, and refinement. Newspapers use soy ink regularly, especially for color because it creates a sharper and brighter image.

However, soy ink is not a perfect solution. It cannot be used in Ballpoint pens and personal printer cartridges. One major problem with soy ink is that it takes more time to dry than petroleum-based inks, due to the lack of evaporative solvents, which are typically **Volatile Organic Compounds (VOC's)**. This is a major challenge for printing presses that use coated papers (such as magazines) instead of porous, uncoated paper (such as newspapers) where ink dries via absorption. Studies into UV-reactive ink curing are being conducted by ink producers. This process dries faster, is cheaper, uses less energy, and emits no VOCs. However, this would require a significant equipment change and has not been scaled down to consumer size so further research is necessary.

## Materials

Glass/pyrex measuring cup

Plant dye (see below)

Stir stick

Paper towels

Paper for printing

Rubber stamp (may make one out of a crossection of a stalk of Ohe, Hawaiian bamboo)

Strainer

Blender

**Option:** By providing a variety of oils, dyes, emulsifiers, and stamps students may design their own inks to determine the best combination for their prints.

**Step 1.** Select your colors that you would like to experiment with

**Step 2.** Gather necessary materials

**Step 3.** Process your plants accordingly to the color you choose and place dye in cup

**Step 4.** Fold paper towel in half twice on top of a counter or plate that will not stain.

**Step 5.** Pour your ink on to the paper towel and let it absorb

**Step 6.** Use either a rubber stamp or your 'Ohe (bamboo) stamp to dip into the ink and print on a clean white sheet of paper



Beet ink from the water beets from the garden were cooked in. A quill pen is useful for 'wicking' up the ink for writing.

compounds (carbon bound to hydrogen) that can either be natural or man made and evaporate very quickly. They aid in drying in the composition of inks.

**Orange/Yellow** – carrot juice

**Red/Pink** – beets or ohelo berry

**Yellow/Gold** – Olena (tumeric)

**Black/Grey** - charcoal

**Purple** - Popolo berry, uki uki berry, pokeberry

**Blue** – uki uki berry with with lime added to dye

**Green** – popolo berry leaves, spinach leaves, or green leaves (puree, strain juice and add 1/2 tsp salt and 1/2 tsp vinegar to 1/2 cup juice from green plant leaves to fix color)

**Red** - Mountain apple skin or achiote

**Pink** – Akala

...and many more plants can be used as dyes, be creative, experiment.

### Suggested vocabulary

**Extract** – a separation process of one substance from another mixture and/or matrix.

**Ink**- a liquid that contains pigments or dyes that is used to color surfaces with an image, text, or design.

**Fixative** – a stabilizing or preserving agent

**Solvent**- a liquid that is capable of dissolving a particular substance resulting in a solution

**Toner** – a powdered dye used in laser printers and photocopiers to print text and images.

**Volatile Organic Compounds (VOC)** – organic

Sloss, Watters, School Garden Curriculum

Achiote (Annatto aka lipstick plant) & Uki uki berry





## References:

Plants in Hawaiian Culture. Krauss, Beatrice. University of Hawaii Press, Honolulu, HI, 2001. (Refer to pgs 65-67 for complete list of plant dyes)

Horton, Robert L; Warkentien, Carol; and Gogolski, Jeanne. 2010. Agriculture in Print: Soy Ink. 4-H Agriscience. Accessed 6/1/2011 from <http://www.4-h.org/resource-library/curriculum/>



Name \_\_\_\_\_

Date \_\_\_\_\_

## Biodegradable Ink Observation Log

List the ingredients in the following table that you used to make your own ink

Plant oil	Dye	Emusifier	Other

How did your ink turn out? Make a print with your stamp below.

Compare your color with another color print of similar color on paper. Is it brighter?



Make a new print on a separate sheet of paper. How long does it take to dry completely?  
(you may test this by smudging with a separate towel)

Can you think of a way to change your color? What would you do?

Can you think of a way to make your ink dry faster? How would you do it?

Can you think of any other products that require an emulsifier?

Why might soybean oil be used rather than a different plant oil?