Cover Crop Products

What can we make from cover crops?

Introduction (~10 minutes)

Inks are made by mixing pigments (color-rich chemicals) with a solution that will not spread or blur on paper. Most inks use petroleum bases, but did you know that you can also make ink using plant oils?

Inks from seed oils, including soy or pennycress, stick better than their petroleum counterparts. (They do not rub off.) They also make paper easier to recycle, are more biodegradable, and are made from a renewable resource!

Gather the materials from the list on the right. (Note that the oils do not need high levels of processing. This means any pennycress oil you have extracted yourself is perfect for this activity!)

Begin by mixing your water and pigment in your plastic cup until it is well-mixed. Then, you will add the oil and stir it well.

When your liquid is well-mixed, stop stirring, and watch it for one minute or more. Do you see oil, water, or solids beginning to separate? Describe what you see.

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Add the lecithin, and then continue mixing your ink until the appearance is as uniform as possible.

Stop stirring, and watch the liquid for another minute.

Do you see oil, water, or solids beginning to separate? Describe what you see.

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Use your ink to draw, write, stamp, or otherwise create a work of art.

Introduction Materials List

- Pennycress or vegetable oil (1 mL or 1/8 tsp)
- Granular lecithin (1 mL or 1/8 tsp, found in health food stores)
- Dry pigment (5 mL or 1 tsp; you can use dry tempera paints, crushed charcoal, ground spices like paprika, or even a sugarless, colored drink mix)
- Water (5 mL or 1 tsp)
- Stir stick
- Small cup (~100 mL or 3 fl. oz.)
- Rubber stamp, traditional dip pen, or a toothpick to use as a stylus
- Paper for printing or writing
- Tools for measuring wet and dry volume

Explore Materials List

- Pennycress or vegetable oil (3 mL or ½ tsp)
- A second oil (3 mL or ½ tsp)
- Water (8 mL or 1½ tsp)
- 4 small cups (~100 mL or 3 fl. oz.)
- Isopropyl (Rubbing) Alcohol (1 mL or 1/8 tsp)
- Granular lecithin (2 mL or ½ tsp)
- Stir stick
- Tools for measuring wet and dry volume

Explore (~25 minutes)

You should have seen a distinct difference in how the solution separated with or without lecithin. Why is that? Let's mix some materials to discover what lecithin does.

For each row on the next page, mix the materials as described. For each row, observe the mixture for one minute or more. Complete the column for observations without lecithin.

Then, stir and add 0.5 mL of lecithin. Observe for another two minutes, and record your observations in the remaining column.

When you are finished, ask a trusted adult how to dispose of the mixtures. (You may be able to turn one or more into ink if you have extra materials!)

Mixture	Observations when mixed WITHOUT lecithin	Observations when mixed WITH lecithin
1 mL Oil #1 and 2mL Water		
1 mL Oil #2 and 2mL Water		
1 mL Rubbing Alcohol and 2mL Water		
1 mL Oil #1 and 1 mL Oil #2		

Explain (~10 minutes)

Which solutions mixed well without lecithin?

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Which solutions mixed better with lecithin?

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Let's take a look at the properties of each.

- Oil is non-polar (charges on opposite sides cancel each other out). It is also hydrophobic (it does not mix well with water).
- Alcohols are somewhat polar. Unlike oil, alcohols are not very hydrophobic. They will mix with water, but not immediately.
- Water is polar (it has positively-charged and negatively-charged sides). It is also hydrophilic (it mixes well with water).

If lecithin helps both polar and non-polar molecules to mix, what is it? Lecithin is a more complex molecule that is an "amphiphilic surfactant." Amphiphilic means it has both polar and non-polar ends, so it can keep water and oils mixed. A surfactant is a chemical that reduces surface tension. With a surfactant, a liquid will lie flat (not "bead up.")

Why would surfactants be an important ingredient in an ink?

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What do you think is the most important ingredient in ink? Why?

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Extend (~25 minutes)

As we've already learned, polarity is an important part of why inks work. In most inks, water is the delivery system for the pigment, and oil helps hold the pigment to the paper. Without a chemical like lecithin, you would have to shake your ink bottle (and maybe even your pen!) before every dip.

There are many other products that had to overcome a similar problem. Have you ever had non-homogenized milk? In non-homogenized milk, cream floats to the top, and the milk must be shaken to spread the milk fat throughout the liquid milk.

Most of the milk we buy has been homogenized. In homogenized milk, milk fat is cut into very small particles so the cream can remain suspended in water. Homogenized milk is a colloid, where the fat isn't dissolved, but the particles are so small that it doesn't easily separate.

For milk to be homogenized, the milk fat particles must be about 1 micron (1 micrometer) in size. A human hair is about 70 microns wide, so the globules of milk fat are far smaller than you can see with your eyes alone.

While we cannot see how particles of milkfat are distributed in milk, we can see how particle size affects our ink.

Follow the steps from the *Introduction* of this module to make two new batches of ink. This time, try using pigments of different sizes than you did last time. Our goal is to compare how the pigment spreads when we compare relatively large, medium, and small particle sizes. Sugarless drink mixes often have very small particle sizes, and ground spices are often larger than most.

Remember that some of your observations can come from your original batch of ink if it is still available.

Extend Materials List

- Pennycress or vegetable oil (2 mL or ¼ tsp)
- Granular lecithin (2 mL or 1/4 tsp, found in health food stores)
- Dry pigment (10 mL or 2 tsp; you can use dry tempera paints, crushed charcoal, ground spices like paprika, or even a sugarless, colored drink mix)
- Water (10 mL or 2 tsp)
- Stir sticks
- 2 Small cups (~100 mL or 3 fl. oz.)
- Traditional dip pen or a toothpick to use as a stylus
- Paper for printing or writing
- Tools for measuring wet and dry volume

Observations

Smallest Particle Size:

I used: ____________________________________

I observed: ________________________________

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Medium Particle Size:

I used: ____________________________________

I observed: ________________________________

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Largest Particle Size:

I used: ____________________________________

I observed: ________________________________

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How did the ink flow differ when pigment size changed? Did one write more smoothly? Did one have a more consistent color?

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This project was developed as part of the IPREFER project (Integrated Pennycress Research Enabling Farm and Energy Resilience) at Illinois State University.

IPREFER is supported by Agriculture and Food Research Initiative Competitive Grant No. 2019-69012-29851 from the National Institute of Food and Agriculture. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the USDA.

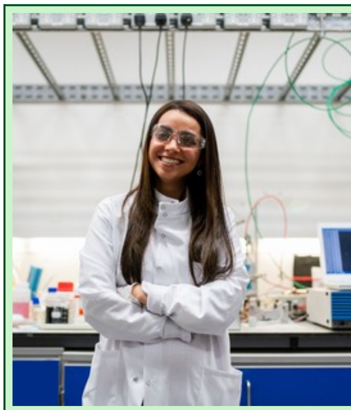
Reflect (~10–25 minutes)

Have you tried to make ink or paints before today? (Many flowers, even dandelions, can be used to make watercolors.) If so, was the ink-making process you used today any different?

Flavor mixes for milk (eg. Nesquik® or Ovaltine®) include soy lecithin. Why do you think lecithin is a key ingredient?

Materials scientists look closely at traits like color, spread, and permanence. How could your ink could be improved?

What experiment(s) could you conduct to find a better recipe? Conduct your experiment and report your results!



Career Connection: Materials Scientist

Many of the materials we use in our everyday lives do not come directly from living things. Many materials are modified by humankind to be better: stronger, more flexible, or more resistant to wear. Materials scientists work to understand and modify the properties of these materials in order to meet human needs.

Materials scientists start with a bachelor’s degree in chemistry, though most jobs require a master’s degree or higher.