Natural Dye

Simple Process

Why Natural Dye?

A SIMPLE NATURAL DYE EXPERIMENT

In 2016, the world consumed over 100 million tons of textile fibers. Dyeing fibers with synthetic or natural dyes uses large natural resources (water, energy, etc.). If not properly treated, these dyes can contaminate the landscape. This natural dyeing protocol is a useful skill but it also demonstrates waters capacity to pick up materials (pigment from plant) from one place and distribute to another (pigment into fiber). Considering the way a fiber is dyed can help design more sustainable processes for the future.

Just like a river picking up nutrients from one location and depositing them in another to make fertile land, water can also pick up toxins from one place and deposit them somewhere we don't want them (e.g. making a site toxic). Clear water may not be safe for drinking as water carries all kinds of visible and invisible, healthy and unhealthy particles that come from industrial and recreational use.

This experiment illustrates how water is such a great solvent, dissolving all kinds of solutes (chemicals). In this case, water picks up the plant pigment and transfers it to the fiber. This experiment makes clean water 'dirty' (with dye, oil, detergent, and a variety of mordants used to 'fix' the natural dye to the fiber) as we dye fibers.

PRE-LAB QUESTIONS

- Where did the materials we use to make a natural dye come from?
- Where do they go when we are done 'dyeing' our fibers?
- What becomes of the 'water' after one is done dyeing fabric?
- Who does dyeing impact?
- Can natural dyes harm the ecosystem as much as synthetic dyes?
- How color fast are the dyes?
- How sustainable are natural dyes?
- How can resources be compared between a natural or a synthetic dye to analyze their relative 'sustainability'?

Health & Safety:

- Only use food items to make your dyes.
- You are provided with several powdered mordants, agents that 'fix' the pigment to the fiber. Mordants included are: Alum, Tartaric Acid, Iron, Soda Ash. These powders dissolve in water and become acidic and basic. Please use gloves and a face mask so you do not accidentally inhale.
- Note: As you are making a natural dye, don't wear clothes that might be ruined if they get exposed to your new dye!

Natural Dye Step by Step Protocol

Ingredients & Equipment

Included in the Making Center kit are:
- Gloves
- Mask
- 8 strips of bleached white muslin
- 1 handful of wool
- Mordant: Alum (Aluminum Potassium Sulfate)
- Mordant: Iron (Ferrous Sulfate)
- Mordant: Tartaric Acid
- Mordant: Soda Ash (Sodium Carbonate)

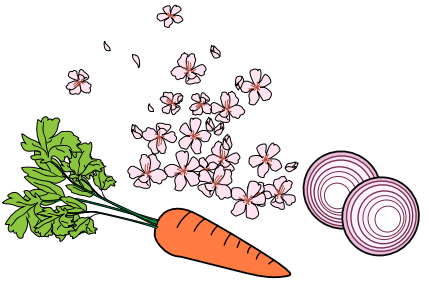
You will need to provide:
- Find a colorful food item to turn into a dye
- Paper towels
- Access to a kitchen stove
- Indelible marker

The following items you can borrow from the Making Center:
- Stainless steel pot
- 6 bowls
- 6 spoons

Note: After picking up your supplies (food item, kit, pot), it will take about 1 hour to complete this experiment and about ½ day for your materials to dry for presentation.

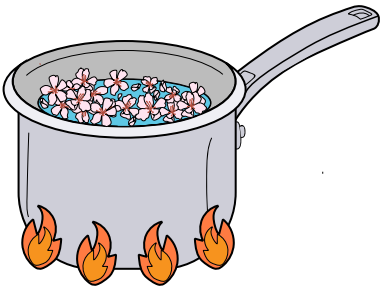
• Step 1.

Select a food/plant Item:
Go to a market and collect a colorful food/plant item you think might make a good dye.



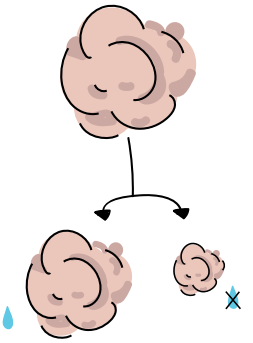
• Step 2.

Extract Pigment:
Simmer (bring to a boil and then turn down the heat) your plant material for approximately 15-30 minutes in your pan. Add minimal water to keep your plant material submerged and maximize dye concentration. As the water boils away, keep adding water over time so that you have enough liquid to fully soak your fiber samples. Adding too much water will dilute your natural pigments (resulting in a fainter dye).



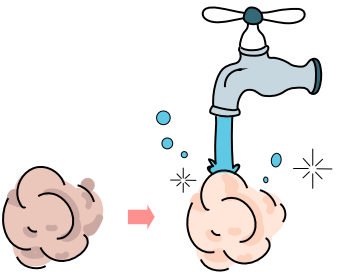
• Step 3.

Prepare Wool Fiber Samples:
While your plant material is making the dye on the stove, wash 90% of your wool in warm water with detergent. Keep a small clump (about 10% of the original clump of wool) of unwashed wool



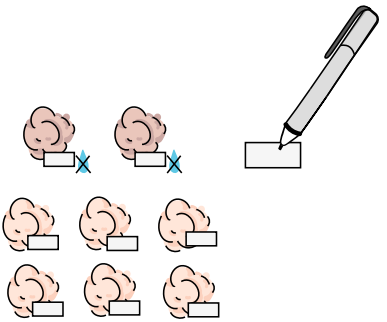
• Step 4.

Washing the wool (90%)
• Before washing wool, smell and feel it (it is coated in oils), note it.
• The detergent removes the oils by 'dissolving' it into the water.
• Wash in two batches (wash one vigorously, and the other gently. Note differences. Do you begin to see how felting wool might happen? Why might removing the oils allow the wool to have different properties?
• Thoroughly remove all the soap.
• Divide into 8 clumps. These are your 8 wool samples.



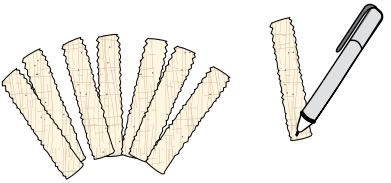
• Step 5.

Now label your 8 wool samples:
1) Negative control (your undyed and unwashed sample)
2) Positive control (dyed and unwashed)
3) Positive control (dyed and washed with water)
4) Experimental sample Alum
5) Experimental sample Tartaric Acid
6) Experimental sample Soda Ash
7) Experimental sample Iron
8) Experimental sample - Optional MYSTERY 'mordant' (vinegar, coke, you choose!)



• Step 6.

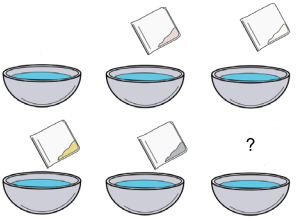
Now label your 8 muslin samples:
1) Negative control (your undyed and unwashed sample)
2) Positive control (dyed and unwashed)
3) Positive control (dyed and washed with water)
4) Experimental sample Alum
5) Experimental sample Tartaric Acid
6) Experimental sample Soda Ash
7) Experimental sample Iron
8) Experimental sample - Optional MYSTERY 'mordant' (vinegar, coke, you choose!)

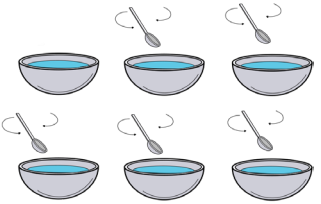


• Step 7.

Prepare Mordant:
While your fiber samples are simmering or soaking in the dye, place 6 bowls on a sheet of paper and label each bowl (with numbers #1-6). Put each mordant (from powder in Ziploc bags) in each bowl, add a cup of water, use a stainless steel spoon to mix until powder is dissolved.
USE A FRESH SPOON FOR EACH MORDANT so as not to contaminate the experiment!. Wash your hands after preparing each bowl of mordant

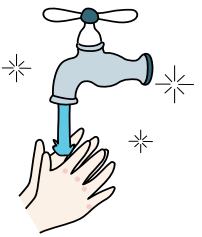
- Bowl 1: just water (to rinse a sample)
- Bowl 2: mordant A
- Bowl 3: mordant B
- Bowl 4: mordant C
- Bowl 5: mordant D
- Bowl 6: mystery mordant (E) of your choice (optional).





• Step 8.

Remember to wash your hands after handling the mordants!

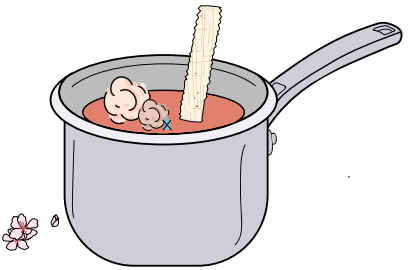


• Step 7.

Congrats! You've made a natural dye! Remove plant materials from the pot Take Note: What color is your water now?

Add the muslin strips (only 7) and wool samples (only 7, leave 1 unwashed sample as your Negative Control) to your dye bath. You are dying a total of 15 samples, 7 muslin and 8 wool. It is optional to simmer the fibers for 30 minutes on a stovetop, or you can also just soak them. Add water if needed to keep your fibers submerged.

Important: Remember to leave 1 muslin strip and 1 washed wool clump out as your negative control (as a reference for what the sample looked like without dye)



• Step 10.

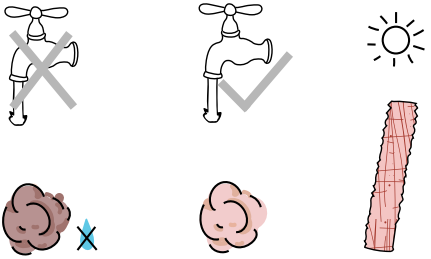
Remove SOME samples from the dye without washing or mordanting:

1) Remove your dyed/oily wool sample (10%-oily, unwashed = no detergent cleaning) (do not rinse). This is your unwashed (oily) wool positive control.

2) Remove one dyed/washed wool sample (10% of wool that was washed with detergent) and set aside (do not rinse). This is your washed wool positive control.

3) Remove one sample of dyed cotton muslin strips and set aside to dry (DO NOT RINSE, Do not put in mordant). This is your muslin positive control – un-rinsed.

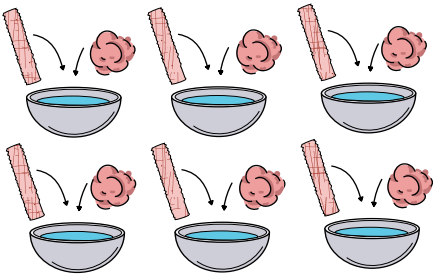
4) Let all 3 samples dry. These are your positive controls for your oily/clean wool and muslin fibers without mordant.



• Step 11.

Remove the rest of your samples from the dye and FIX these samples in the different mordants you have mixed in bowls #2-6.

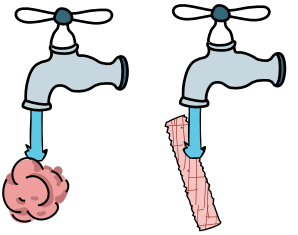
Place 1 piece of dyed cotton and 1 small clump of wool fibers (cleaned with detergent) into each bowl (bowls 1-6) and let sit for 30 minutes. Make observations, drain bowls.



• Step 12.

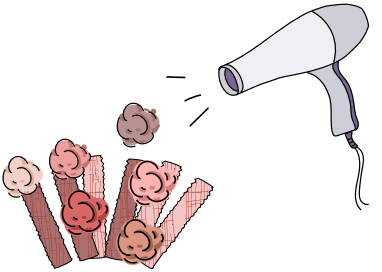
Rinse (cotton/wool treated with mordant) with fresh water. Let dry. Keep the wool with labelled cotton to keep track of which mordant treated each batch of samples.

Wash your hands in between working with each mordant so as to not contaminate results.



• Step 13.

After drying, attach all samples of your dyed fabrics (cotton and wool) to a note card (with your name, the food material you chose and the description for each treatment of your fibers). See the reference image below.



Key Words:

COLOR FASTNESS color resistance to fading or running.

DOWNSTREAM situated or moving in the direction in which a stream or river flows

MORDANT a mordant is a substance that combines with a dye or stain and thereby fixes it in a material (it helps the pigment to stick to the fiber so it doesn't 'wash' away).

NEGATIVE CONTROL a sample in an experiment that acts as a standard in which no response is expected.

pH a measure of acidity and alkalinity of a solution that is represented by a number on a scale (0-14) where 7 represents neutrality. Lower numbers (below 7) indicate increasing acidity and higher numbers (above 7) indicate increasing alkalinity (basic).

POSITIVE CONTROL a sample that receives a treatment so that this positive response can be compared to both the negative control and the various treatments of experimental samples with unknown response.

SIMMER To bring to a boil and then turn down the heat so the water does not bubble.

SOLUTE the minor component in a solution, dissolved in the solvent. (e.g. salt is a solute in sea water)

SOLVENT ability to dissolve other substances (e.g. water is an incredible solvent, it dissolves all kinds of chemicals, often called 'solutes'. E.g. salt is a solute dissolved in ocean water).

Key References:

1. "Colors of the Cauldron": NYT, 2012:
http://www.nytimes.com/2012/04/05/garden/anew-generation-discovers-grow-it-your-self-dyes.html

2. Natural Dye Recipes:
Urban Dyer's Almanac: http://www.urbandyersalmanac.com/
Textile Links: http://www.textilelinks.com/dye/natinfo.html (some links are broken)
Kits: http://www.aurorasilk.com/

3. Making Patterns with Dyes:
https://www.bbg.org/gardening/article/diy_shibori

Reference Images:

AWAVE AWAKE Spring/Summer 2018 https://www.awaveawake.com/about/

EILEEN FISHER SUSTAINABLE FASHION VISION 2020 https://www.eileenfisher.com/vision-2020/

SATSUMA Earthly Delight Collection by Özge Horasan https://www.thelissome.com/blog/2017/8/11/the-wisdom-of-natural-dye-qa-with-zge-horasan-of-sat-su-ma

MIXED COLOR by Christi Johnson https://www.mixedcolor.net/

Additional Notes on Experiment Module:

Technical Summary

1) Water is a solvent
   - It absorbs the detergent into solution. With the detergent the oils from the wool also dissolved into the water.
   - It absorbs the food pigment into solution– the water now carries color (is it 'dirty'?).
   - It absorbs the mordant powder into solution – the water now carries the mordant
   - When water receives the natural dye it acts as a carrier of color to the fabric.

2) The water acts as a carrier of pigment in liquid form so the fibers can 'pick-up' the dyes easily. The oily wool resists water and thereby resists the dye. More sophisticated protocols will use a chemical to 'clean' the wool and prepare it to receive the water-dye solution better.
3) The pH of tap water is ~7, the pH of the mordants vary.
4) Putting dyed fiber samples into the mordant changes the color by changing the chemistry as the mordant 'binds' the pigment to the fibers.

Conceptual Items Explored.

In sum, water is a great carrier of materials. In this case, it did something we wanted it to do – namely dye fiber by moving pigment out of the plant and into the wool or cotton fiber. We have disposed a variety of different chemicals down the drain (detergent, wool oil, food chemicals, alum, etc) all of which will be treated in our sewage treatment plant before that very water is released into the NYC bay. Are sewage plants able to remove everything we put in our water and flush down the drain? After considering downstream impacts of natural dyeing, now consider where the food product came from? What did it take to make the food product that made the 'natural' dye? What are the upstream considerations of natural dyeing?

Experiment Reflection:

1) What plant material did you choose? Where do you think it was grown? How many chemicals or gallons of water were used to grow it? How far do you think it traveled to the store?

2) Was the color different between the oily and clean wool samples? Describe the differences.

3) Was the color different between the cotton samples (dyed-not-rinsed, dyed-rinsed, dyed-mordant-rinsed)? Describe the differences. How was the color different between the cotton and wool samples? Propose reasons Why there were differences in coloration between samples. Or google!

4) You dyed two natural fibers (cotton and wool). Hypothesize (guess) how the natural dyes might work on synthetic fabrics such as polyester (or test your natural dye with a synthetic fiber!).

5) How satisfied are you with the outcome?

6) To do this tiny natural dye experiment, you used water in many different ways and disposed it in a sink. List all the things the water picked up and you put down the drain.

7) Is it ok to put your waste water samples in the drain? Why? How is it different than industrial quantities of natural dyes or synthetic dyes?

8) Now think of the tons of fibers that were dyed this year for fashion (see the steps, processes, and chemicals used in this flow chart describing "Wet Process Dyeing": https://textechdip.wordpress.com/contents/wet-processing/). Imagine 1 innovation that fashion or home décor designs might do to reduce pressure on clean water necessary for drinking and bathing (what could you eliminate, reduce, change, improve)?

9) Reflections: Will you do more natural dyeing? Were you surprised? What might you consider if using natural dyes in your own projects/products? What has not been considered? Why do you think natural dyes are uncommon? Do you think natural dyes are safer for the environment? Why or why not?

What do you think?

Sustainable Systems

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