



Why Natural Dye?

Natural dyes are colors that are extracted from plants (and insects). Natural dyes have been used for thousands of years to produce color, and it is only in the past 160 years that synthetic dyes were invented. Recently, a growing environmental awareness has brought about a renewed interest in using natural dyes. As a result, there has been a debate about whether synthetic dyes are better than natural (plant or insect derived) dyes. The following is a very brief discussion of the pros and cons of dyeing with natural dyes vs. the most popular types of artisanal (for handcrafting use) synthetic dyes:

Synthetic Dyes:

Mauve by William Perkins invented the first synthetic "aniline" dye in 1856. In the early days of synthetic dyes a concern about pollution and worker safety issues came into play. Certain types of cancers were linked to exposure of early aniline dyes, and this resulted in a phasing out of their use and manufacturing. Today, of all the synthetic dye options available, Fiber Reactive Dyes are the most permanent type of dyes. These dyes form a covalent bond with the fiber molecule. For this reason, Fiber Reactive Dyes are often the dye of choice for baby clothing and chemically sensitive people, since the dye is very permanent after a thorough rinse and wash.

Acid Dyes are another class of synthetic dyes for use on protein fibers. Acid Dyes bond to protein fibers when used at the right temperature in an acid environment. Non-toxic household white vinegar or mild citric or acetic acid are used with heat to facilitate the fixing of the dyes. Acid Dyes form Hydrogen Bonds with the fiber, which are

not as strong as covalent bonds, but still very wash fast. Acid Dyes are considered low impact because when used in the correct proportion to the weight of goods being dyed, almost all the dye is taken up by the fabric. This is called exhausting the dye bath. Although chemical dyes are very stable and predictable to use, they are still toxic, create waste and pollute the environment.

Natural Dyes:

There are some cons to using natural dyes; they are less permanent, more difficult to apply, less wash fast, and most require the use of mordants, which bond to the fiber on one end and the dye molecule on the other. The amount of water and energy used to create natural dyes is also greater than chemical dyes. Some pros to using natural dyes; when sourced and prepared with proper protocols, natural dyes are a safer and less costly alternative to synthetic dyes. The growing and production of natural dyes has the potential to help support smaller farming and artisanal economies. Designers can use natural dyeing methods to promote regenerative farming practices and soil to soil production systems. These practices can help to sequester carbon and produce no waste. Colors that are derived from nature have aesthetic appeal, and once the fiber is prepared to accept the natural dye, there are a variety of colors that can be achieved by simple pH alterations of the dye bath.

Natural Dye Step by Step Protocol

Ingredients & Equipment

Included in the Making Center kit are:

- Pair of latex gloves
- Disposable mask
- 2 oz wool fiber
- Tartaric acid
- 1tbsp Alum (Aluminum Potassium Sulfate)
- ¼ tsp Iron (Ferrous Sulfate)
- 1tbsp of Soda Ash (Sodium Carbonate)
- pH strips and color key

You will need to provide:

- Plant materials -leaves, barks, berries, flowers
- Vinegar (acetic acid)
- Lemon Juice (citric acid)
- 1qt Mason Jars (3)

The following equipment is provided in the dye lab L901 for students who attended orientation

- (1) 12 or 16 quart non reactive pot (stainless steel, non-stick coated or porcelain-no aluminum or copper)
- (3-4) 1 quart saucepans or small bowls (stainless steel, non-stick coated or porcelain-no aluminum or copper).
- (1) Thermometer
- (1) Strainer
- (1) cutting board
- (1) knife
- (1) set of measuring spoons

Health & Safety:

Observe safety when dealing with plants because some can cause allergic reactions. WEAR RUBBER GLOVES, and a dust mask throughout all stages of the natural dye process. In the dye process, *mordant salts are usually the most toxic problem. DO NOT USE THE SAME POTS AND UTENSILS THAT ARE USED FOR COOKING.

• Step 1. (Phase 1)

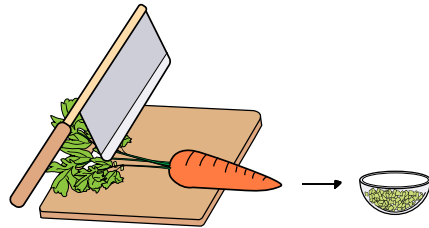
Collect plant materials (leaves, barks, flowers, berries) from your neighborhood greenmarket, park, or backyard.



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- **Step 2.**

Cut, chop, or crush the dye material so it will fit into a 12 or 16 quart stainless steel dye pot.



- **Step 3.**

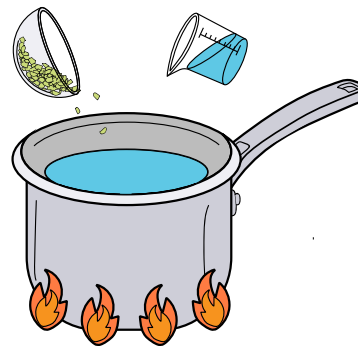
Weigh the dye material on a scale and document the weight in grams or ounces.



- **Step 4.**

Put the dye material into a 12 or 16 quart stainless steel pot and measure out water in quarts or liters. Use enough water so the dye material can move freely in the pot, but be sure not to add too much water or you will dilute the dye intensity. Document the amount of water used.

Heat on a stovetop for approximately 1 hour. Avoid boiling, as some plant materials are sensitive to high temperatures.



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- Step 5.

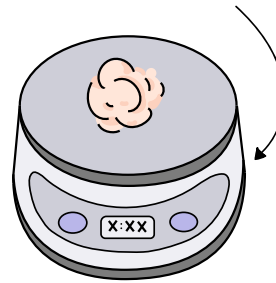
Separate the extracted dye from plant materials using a strainer and an additional stainless steel pot or bowl.

Set aside the exhausted plant materials for composting. Do not throw them into the garbage, as they will end up in a landfill.



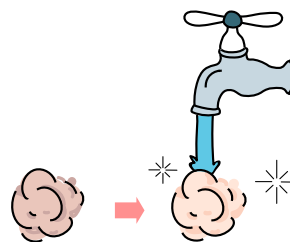
- Step 6. (Phase 2)

Weigh out the fiber (wool fleece, textile, yarn) on a scale. This will give you the WOF (Weight of Fiber). Document the WOF in grams or ounces. You must weigh dry fiber. If the fiber is a "greasy" wool fleece it first must be *scoured to remove lanolin (see "About Scouring" in additional notes).



- Step 7.

Wash fiber gently with pH-neutral soap in lukewarm water. Gently squeeze out excess water. Set aside.



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- Step 8.

*Calculate the amount of mordant needed for the type of fiber you are using (see below "about mordants" and ratios).

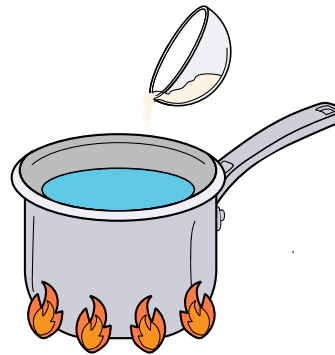
Weigh out the mordant amount on a scale in grams or ounces.

Strain the mordanted fiber using a colander or strainer.



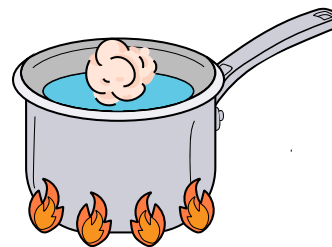
- Step 9.

Transfer the mordant into a 12 or 16 quart stainless steel pot. Add enough water so the fiber can move freely in the dye pot. Add the fiber after the powdered mordant is dissolved.



- Step 10.

Heat up the fiber to 180 degrees Fahrenheit (or 82 degrees Celsius) for 45 minutes to 1 hour. Use a thermometer. Do not let the fiber boil. Reduce heat and let cool.



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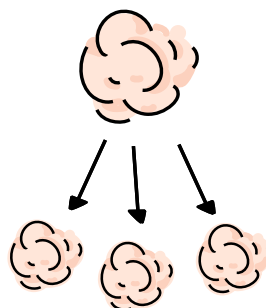
- Step 11.

Strain the mordanted fiber using a colander or strainer.



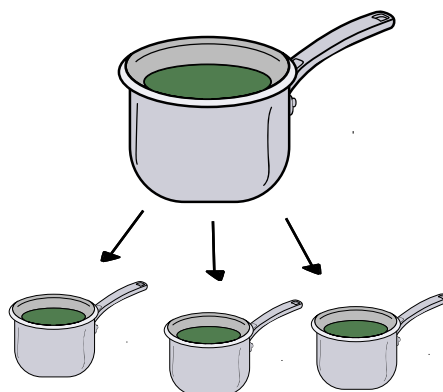
- Step 12.

Divide the mordanted wool into three to four bundles and set aside.



- Step 13.

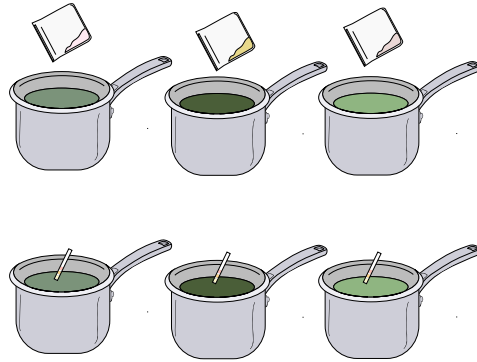
Divide the dye bath into three separate dye baths.



- **Step 13.**

Add assistants to the dye pots. Vinegar, Cream of Tartar, Tartaric Acid or Citric Acid will turn the dye bath acidic. Soda Ash will turn the dye bath alkaline. Iron will not change the pH, but it will shift the colors of certain plants. (see "about pH assistants below).

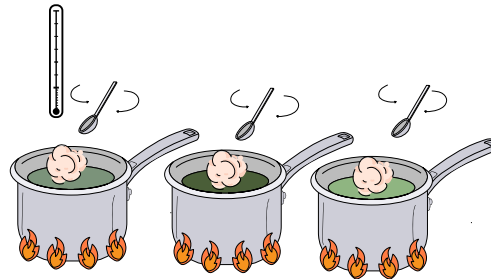
After adding assistants to the dye pots, use a pH strip to see how the dye bath changes. Record findings on the Urban Dyer's Almanac Worksheet.



- **Step 14.**

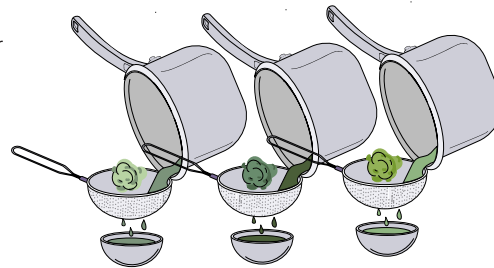
Add the mordanted fiber to the dye pots and heat up to 180 degrees Fahrenheit (82 degrees Celsius) for approximately 45 minutes to 1 hour. Be sure to stir gently and frequently.

Remove from the heat and let cool.



- **Step 15.**

Strain the fiber from the dye using a colander or strainer.

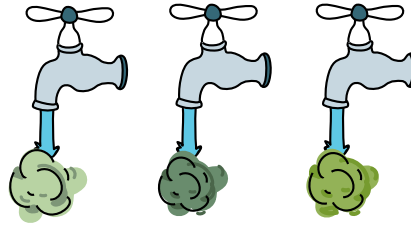


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- Step 16.

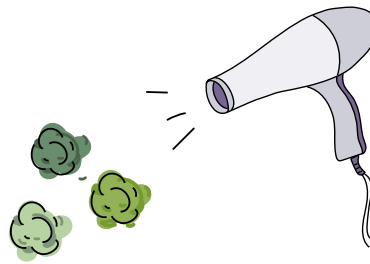
Wash in lukewarm water using a pH neutral soap. If you are rinsing wool, do not wring, as this will potentially felt the fiber. Rinse until the water runs clear.

Lay the fiber out to dry. Do not dry in the sun.



- Step 17.

Lay the fiber out to dry. Do not dry in direct sunlight.



Key Words:

ASSISTANT Ingredients in a dye recipe to aid dyestuff to become fixed to the fiber. Causes fiber to bloat or swell enabling better color penetration.

COVALENT BONDS Are when two atoms in a molecule share an electron. Once the bond is formed you have one molecule; the dye molecule has become an actual part of the fiber molecule and nothing will take it off except bleach or other "discharging" chemicals

CELLULOSE FIBER A fiber composed of cellulose; cotton, linen, jute, hemp.

DYE BATH The solution in which dyeing takes place.

EXHAUST To bring about total absorption of dye into fiber.

FIBER A unit of matter, either natural or synthetic that forms the basic element of fabric and other textile structures.

HYDROGEN BOND A weak bond between two molecules resulting from an electrostatic attraction between a proton in one molecule and an electronegative atom in the other.

MORDANT Substance that has the property of fixing or setting colors into fiber.

pH A figure expressing the acidity or alkalinity of a solution on a scale on which 7 is neutral, lower values are more acid, and higher values more alkaline.

PROTEIN FIBERS Fibers of animal origin such as wool, alpaca, camel, silk.

SCOURING Removing dirt, grease, and other impurities from fiber by dissolving a liquid soap or detergent in water and heating it up with the fiber.

SODA ASH Crude sodium carbonate, strongly alkaline. Can be used in the natural dye process to alter colors. Used with synthetic dyes as a fix.

Key References:

1. Botanical Colors "How To"
<https://botanicalcolors.com/how-to/>
2. Maiwa Instructions
<https://maiwa.com/pages/instructions>
3. India Flint
<http://indiaflint.com/index.htm>
4. Dogwood Dyer
<http://www.thedogwooddyer.com/about1/>
5. Textile Lab
<https://www.newyorktextilelab.com/>

Reference Images:



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



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



L. 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>
R. MIXED COLOR by Christi Johnson <https://www.mixedcolor.net/>

Additional Notes on Experiment Module:

ABOUT SCOURING:

"Greasy" or unwashed wool fleece contains natural oil called lanolin. Lanolin is the byproduct of wool production and is used in the manufacturing of lotions and lip balms. You can purchase bottled lanolin at many health food stores. Lanolin must be removed before mordanting or dyeing fiber. Synthrapol (are both available in dye lab?) can be used to scour fiber at a ratio of 1 teaspoon per pound of fiber.

1. Use a large vessel so the fiber can move around freely.
2. Add water and 1 teaspoon of Synthrapol
3. Slowly heat up and simmer fiber for 1 hour. IMPORTANT: when scouring wool bring the temperature up slowly and allow the fiber to cool completely before rinsing. DO NOT AGITATE. DO NOT BOIL.

ABOUT MORDANTS:

There are two kinds of natural dyes. **SUBSTANTIVE** dyes do not need mordants to fix to the fiber. Some substantive dyes are black walnuts, fustic, myrobalan* and indigo. Most plant dyes are **ADJECTIVE** dyes, and they require a mordant. The mordant joins the fiber to the dye to permanently fix it. There are different mordants and each will draw out a different shade of color. There are some metal mordants that are toxic such as copper, tin and chrome. Since these mordants are bad for our bodies and the environment, we will only be using alum, iron, and tannin. Typically, Alum (aluminum potassium sulfate) and Iron (ferrous sulfate) are used for protein (animal) fibers, while tannin, myrobalan, aluminum acetate and iron can be used for cellulose (plant) fibers.

ALUM Potassium aluminum sulfate is the mordant most frequently used for protein fibers. Alum keeps colors clear (does not tint).

TANNIN Tannic acid is a mordant used with cellulose fibers. Alum does not bond as easily to cellulose fibers as it does with protein fibers. Tannic acid will influence the color of the fiber.

ALUMINUM ACETATE is sometimes used as the preferred alum mordant for cellulose fibers and fabrics. It is refined from bauxite, and is blended with acetic acid. For this reason, some natural dyes develop to a richer shade on cellulose. Aluminum acetate keeps colors clear

(does not tint).

SYMPLOCOS is a plant that functions as a bio-accumulator of aluminum. The leaves naturally store alum and so by harvesting the plant, drying and grinding the leaves, dyers can access an organic supply of alum that is not strip mined.

MYROBALAN this dye is from the nuts of the Terminalia chebula tree, which grows in Asia. It may be used as both a mordant and a dye giving a buttery yellow color to the fiber. The color works well for over dyeing and imparts a warm yellow color on the fiber. When used as a tannin mordant use at 15% WOF (weight of fiber)

IRON Ferrous sulfate is a mordant that helps with color and light fastness, and is used as a color changer. It works very well on cellulose fibers and should be used with care on protein fibers, because it can make them brittle. Iron shifts the color to a deeper, darker shade, often called "Saddening" the color.

MORDANT RATIOS:

Use the ratios:

- Alum at 15% WOF (Weight of Fiber)
- Iron at 2% WOF
- Tannin at 10% WOF
- Myrobalan at 20% WOF
- Aluminum Acetate at 15% WOF

ABOUT pH ASSISTANTS:

Cream of Tartar or Tartaric Acid This will turn the dye bath to a more acidic solution. It also helps soften the fiber when harsh mordants are used (Iron). And will brighten reds and yellows (it will turn the color of cochineal to a true red).

Vinegar (Acetic Acid) This will turn the dye bath to a more acidic solution. It can be used in small quantities to help wool and silk absorb the dye. It can also be used as an after bath to alter the dye color.

Lemon Juice (Citric Acid) This will turn the dye bath to a more acidic solution and will alter the color of some dyes. It can be used as an after bath, or added to the dye pot.

Soda Ash This is used to alter the color of some dyes. It also helps soften the fiber when harsh mordants are used (Iron). Add to the dye bath to create a more alkaline dye bath.

Urban Dyer's Almanac Dye Worksheet

Plant collected:

Date collected:

Part of plant used and amount:

Extraction process notes:

Dye Recipe:

Material / WOF (Weight of Fiber):

Dye / Volume:

Mordant / amount:

Additions:

Recipe notes:

Experiment Reflections - What do you think?

RESULTS / INTERPRETATIONS

1. Did the work come out as expected (or as you hypothesized)?
2. Did your plants create the colors you expected?
3. Which plants created the greatest variety of colors through pH manipulation?

RESULTS / INTERPRETATIONS

1. What new questions do you have?
2. What would you do differently next time?
3. What types of products could you apply the colors you created to?
4. What other systems connect to the natural dye process? For example: Food? Manufacturing? Explain how they are related and how healthy ecologies can be fostered within these systems.
5. How might the development and use of natural dyes create interdependencies in supply chains?

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