

Indigo Dye: Plants & Process

5th/6th Grade Garden Lesson

Objective: Students will be introduced to plants used for natural dyeing, specifically plants that produce the color blue. They will learn hands-on how to “cold dye” using fresh Japanese Indigo leaves (*Persicaria tinctoria*) and watch the chemical reaction that takes place during the dye process.

Materials:

clipboards with step by step dye directions (optional: dye history handout)
enough *animal fiber* swatches (wool & silk) for each student to take one home
optional: single *plant fiber* swatches per group for comparison (cotton & linen)
wooden spoons and/or tongs
fine wire mesh strainers
paper towels just in case!
containers for holding fresh dye bath; containers for holding clean rinse water
Plastic gloves for students (fresh indigo may irritate skin tho it is rare; fingernails sometimes turn turquoise if submerged in dye bath too long!)
aluminum cookie sheets for group fiber swatch drying
non-food designated blenders
fresh Japanese indigo plants harvested shortly before lesson

optional:

additional sample plant parts for natural dyes (dependent on season) such as:
walnut husks, acorns, lichen, cotton bolls, flax, calendula & marigold flowers, etc.
pre-dyed sample fabric swatches showing color variations (e.g. on poster board)

Procedure: 40 min class/18 students

*Break class into 3 groups of 6 students ahead of time

Intro/Overview – 10 min: *students gather at school garden dye bed*

Last year in 4th grade you learned about Colonial Times in social studies and if early American colonists could see the clothes you’re wearing today they’d be amazed! Not only because they had to make their own clothes by hand, but because they even had to make their own dyes to color their clothes – and that process was NOT easy. In fact, to dye fabric colonists had to know their plants, understand chemistry, and have an artistic eye for color. So today, you, too, are going to try your hand at a little “plant chemistry” to see if you can magically create the color blue!

Point out plants in dye bed that can give blue; 3 most common indigo sources:
From India: Indigo (*Indigofera tinctoria*) bean plant family - *Fabaceae*
From Europe: Woad (*Isatis tinctoria*) cabbage family - *Brassicaceae*
From Asia: Japanese Indigo (*Persicaria tinctoria*) buckwheat family - *Polygonaceae*

Talk about how hard it was to make blue from woad in Europe – why Royal colors are reds and blues and purples.... Later trade opened up indigo from India; later still American Colonies grew indigo as export crop etc. In Japan art form called “Shibori” using indigo.

To get dark blue is a complex process in which *indigoferin* (the chemical compound in the plant that gives blue pigment – show blue edges visible sometimes on a leaf) has to be released from leaves into liquid so it can attach to fibers. In order for it to attach to fibers you have to first add oxygen into the liquid by frothing/beating air in so the color will release/be trapped in the liquid. Then to get the color to attach to fibers you use a chemical ‘reducer’ (in the old days they used fermented urine!) to remove the oxygen so the color will attach to fibers you put into the liquid. When you slowly remove the fiber from the liquid and it hits the air the oxygen allows the color to ‘fix’ to the fiber – this means it *oxidizes* – and you get blue.

Common question: How do you keep color from washing out? Some natural plant dyes are better than others at “sticking/affixing” to fibers but in many cases a **mordant** is used. **MORDANT** is any substance (such as iron or aluminum) that helps dye color bond or ‘stick’ to fabric so that the color doesn’t vanish or fade over time. Mordants can also affect color intensity or change colors entirely by chemically reacting with the dye bath, so they can also be a variable in dyeing (show students acorn color results from iron vs. alum).

There are many **VARIABLES** that can affect dye color such as plant part used (leaf vs. stem vs. root), temperature of dye bath, time left to soak, fiber type (animal vs. plant fibers), even type of soil, climate plant growing in, etc.

Dye process: Let’s get started! 25 min

We don’t have time to make the more complex “indigo vat” in class to get the dark blue indigo color – that takes several hours! But we can make a fresh indigo dye bath just by blending Japanese Indigo leaves with water.... And we’ll still get color!

Students split into 3 groups. Adults assist students in each group to follow attached dye directions step by step. Once fabric is removed from dye baths (leave in about 5 min!), students rinse and place swatches on their group’s aluminum tray.

WRAP-UP lesson: 5 min

Let your fabric swatches dry on your trays and when you come to class next see if the colors have changed again – compare group colors to see if there was any variation across groups...

Time permitting, show some of the other plants in school garden not in the dye bed that also give color... cosmos, ironweed, eucalyptus, pokeweed, jewelweed, etc. Show students sample colors/dyed fibers from these plants.

Resources:

Japanese Indigo tutorials:

<https://www.youtube.com/watch?v=g8EOTa94ie8>

<http://lindahartshorn.com/blog/?p=134>

<https://botanicalcolors.com/faq/indigo-faq/>

“**Indigo** works differently than other natural dyes. Most other dyes require you to extract the dyestuff (color) from the raw plant material by making a “tea” of dyestuff and liquid, boiling and simmering until the color has transferred to mordanted fibers. The color bond between the mordanted fibers and the dyestuff is a **chemical bond**. Indigo requires that excess oxygen be removed from the vat liquid, which makes the indigo color molecule (called indigoferin) available to physically attach to fiber. When the fiber is immersed in the vat, indigo attaches weakly to the fiber. The fiber in the vat is not blue at this time. It’s yellow-green, and scientists call this “indigo white” or “leuco indigo”. **OXIDATION** is when the indigo fiber is removed from the vat. Oxygen in the air reconverts the weakly attached indigo and allows it to attach to the fiber, forming a stronger bond and allowing the blue color to emerge. This is almost magical - you see a yellow-green fiber slowly change to blue before your eyes.”

Fiction Books with indigo themes:

(for younger ES grade levels 1st-3rd)

Viswanath, Shobha. The Blue Jackal. Eerdsmans Books. Michigan: 2014.

(for upper elementary/middle school students, even high school)

Lowry, Lois. Gathering Blue. Houghton Mifflin. New York: 2000.

(for upper middle school/high school students)

Boyd, Natasha. The Indigo Girl. Blackstone Publishing. Oregon: 2017.

Additional Children’s Books on dyeing, weaving, fiber arts etc.

Blood, Charles and Link, Martin. The Goat in the Rug. Four Winds Press. New York: 1976.

Ogier, Susan. Talking Textiles. Cherrytree Books. Minnesota: 2009.

(Spanish/English version)

Marshall, Linda Elovitz and Chavarri, Elisa. Rainbow Weaver/Tejedora del Arcoiris. Children’s Book Press. New York: 2016.

****Purple came from sea snails:** <https://www.smithsonianmag.com/smart-news/in-ancient-rome-purple-dye-was-made-from-snails-1239931/>

Expansion Activities:

LEAF PRINTS:

Japanese Indigo and Woad leaves can also be pounded between 2 sheets of cotton cloth to make blue leaf imprints. This can be done with a hammer, mallet, or simply a smooth rock. Students let the green leaf imprints dry completely (a week is best) then peel away the plant matter. Cut the 2 halves of the imprint and wash just one side to compare color to the unwashed side! Wash the fabric in soapy water (use mild, clear dish detergent) and watch the imprint turn blue once it oxidizes. Allow washed side to dry again to see if color intensifies/changes further.

Leaves can also be rubbed using rocks/rolling pins in between thicker white cardstock paper and allowed to oxidize until blue color appears. This is a faster approach and color can be seen almost instantly though will deepen over time. Requires no washing and can go home with students day of!

SALT RUB METHOD:

Dye can be extracted from Japanese Indigo and Woad leaves by using coarse salt (e.g. kosher salt). The salt pulls the moisture from the leaves, though a bit of water can be added to speed up the process. *Students should wear gloves to protect salt from irritating any small cuts/wounds in skin.* Place a handful of leaves (no stems or flowers!) in a small container (plastic or aluminum take out trays work well) with salt and crush/knead with hands until moisture begins to pool. Add clean scoured silk and knead into/with leaves. Keep kneading until silk darkens green. The longer you knead with leaves, the darker the color will be. It also helps to let fiber sit in leaf mash for a while. Remove from leaf mess and rinse in water. Hold up to air and watch color turn turquoise blue. Wash in soapy water and see if color changes further. Dry on trays to see if color changes even more, or send home in plastic baggies that day with students.

**Wool may be used in place of silk but will be harder to wash out leaf bits and may start to "felt" itself. Cotton and linen (plant fibers) may be used for comparison but these will take color less well than silk and wool (animal fibers).*

**Woad leaves may only be used from first year's growth – once the plant flowers and goes to seed the leaves are no longer viable. Woad is a biennial so plant yearly to ensure you save seed and also have fresh leaves for dye! As a woad dye bath ages it will lose its ability to give blue but will give reddish colors – pink, tan, brown etc. A salt rub solution used again the following day might give students different colors!*

Fresh Dye Process with Japanese Indigo

1. place animal fibers (**silk & wool**) into clean water to soak; you may also soak plant fiber (cotton & linen) to compare
2. strip **ONLY** the indigo leaves from stems and put into blender; set aside & save any flowers/seeds on stems
3. use tongs or spoon to pack leaves into blender (don't use hands!); add just enough cold water to cover leaves
4. put lid on blender and pulse (*puree mode!*) until leaves pulverized (if need be, stop to pack leaves down to make sure all are chopped)
5. *this is your **dye bath!*** Let sit for a minute or so then pour liquid through sieve into a bowl to strain off chopped leaves
6. remove soaking fibers; squeeze out excess water, "uncrumple" fibers, and gently place in dye bath so completely submerged
7. let fibers soak 1 to 5 minutes; put gloves on at this point to protect skin from the dye (some people may be sensitive to indigo)
8. **optional:** *remove one fiber piece after just 1 minute to compare to fibers left longer in dye bath*
9. using tongs or gloved hands, remove fibers from bath and squeeze out excess liquid; *what happens when fiber is exposed to air?* Quickly plunge/rinse fiber in water and remove; look to see what color you get!
10. place fibers on tray; *does the color continue to change? compare color of wool vs. silk vs. plant fibers; what might cause any differences?*
11. remove gloves; bring trays inside and let dry completely

Salt Rub Process with Japanese Indigo (or Woad)

1. place animal fibers (**silk or wool**) into clean water to soak; you may also soak plant fiber (cotton & linen) to compare
2. strip **ONLY** the indigo leaves from stems and put into small dish or container; set aside & save any flowers/seeds on stems (pull Woad leaves from base of plant; do not use if flower stem visible)
3. scoop about 1 tsp kosher salt (or more, depending on amount of leaves) with a spoon and sprinkle over the leaves in container
4. **put on rubber gloves!** using both hands knead/crush/squeeze leaves and salt together until leaves begin to break down from salt and release moisture
5. squeeze the leaves into a ball and check to see if liquid appears; if yes, this is your **dye solution**; add silk piece to solution and begin to work into the leaf/salt mix (if you have trouble getting moisture from the leaves you may add some water)
6. continue to work silk until fiber starts to take color; the longer you work the fiber into the dye solution the better/deeper your color will be! Let the fiber sit for a few minutes under the leaf/salt pile to darken color
7. **optional:** *remove one silk piece sooner than the other to compare colors later*
8. when you think your fiber has enough color, remove silk from dye solution and brush off excess leaf bits; *what happens when fiber is exposed to air?* Look for any color changes. Then plunge/rinse fiber in water and remove; look again to see what color you get! Add some mild dish detergent and again check for color change.
9. place fibers on tray; *does the color continue to change as fiber dries? compare color of wool vs. silk vs. plant fibers; what might cause any differences?*
10. remove gloves; bring trays inside and let dry completely or take home wet samples in plastic baggies