

How Natural Textile Dyes May Protect Health and Promote Environmental Sustainability

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STORY AT-A-GLANCE

- › Synthetic textile dyes may be a hidden source of endocrine-disrupting chemicals that may impact your health and fertility
- › There's a slow-growing movement toward ancient holistic plant-based dyeing processes that addresses a number of concerns, including human and environmental health concerns, and societal welfare
- › Up to 70% of the global use of dyes are azo dyes, which are among the most hazardous. Fibershed is a resource for creating safe, organic textile dyes using plant- and vegetable-based pigments

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Most people never give a thought to how a piece of clothing was given its color. Unfortunately, if you don't, you could unknowingly expose yourself to hazardous chemicals on a daily basis. Fabric dyes are also a significant environmental concern, contributing to pollution – oftentimes in poorer countries with lax regulations on toxic chemicals to begin with.

Rebecca Burgess, author of "[Harvesting Color: How to Find Plants and Make Natural Dyes](#)," has two decades' worth of experience in this area and is the executive director of Fibershed – a word she coined – which is a resource for creating safe, organic textile dyes.

"I started this work when I was taught to train young children in how to use dyes when I was in college," Burgess says. "It was a textile art summer program [and] I was in charge of direct instruction for [a group of] 9-year-olds. It was a summer job. It exposed me to the arts and crafts side of textile dyeing ... I was helping them use these compounds to color t-shirts.

We had to wear gloves. I had to wear a mask. People had to wear aprons. We couldn't let the powder get in the air. We were so careful once we opened these jars of powder to not get it in our lungs or on our skin. The ingredients list wasn't very clear.

The molecular breakdown of what was in the material wasn't clear, but the producers of the dyes were asking anyone who uses them to be very careful with inhalation and exposure, especially skin exposure ... A light bulb went off. 'Why am I having children use a material that they have to wear masks and gloves [to use]?' While we're making the dye, we're suited up.

And then we take the T-shirt out of the bucket. We rinse it a little, and then we put the T-shirt on our bodies. Somehow it's OK to wear the stuff on your skin, but it's not OK to touch the powder? There was a chasm between what seems like solid logic in what we were willing to expose ourselves to and why we were doing what we were doing."

Plant-Based Versus Synthetic Dyes

At that time, more than 25 years ago, Burgess used the search engine of the time (Ask Jeeves) to inquire about alternative dyes and discovered you could use things like **onion** skins, **cabbage** and **beets**. Armed with onion skins, cabbages, beets and hand-harvested **blackberries** and **dandelion leaves**, Burgess set to work learning how to create natural dyes.

"I just started bringing food-based products into our textile program. The kids started cutting up vegetables and putting it in pots of water, heating it up and

making tie-dye T-shirts, but with cabbage, collard, onion, beets, blackberries and dandelion. And then we can take that fluid, cool it down, and then pour it back out on the lawn. It was tea essentially."

Over time, Burgess discovered industrial dyes contain a number of fossil carbon-based chemicals known to be endocrine disruptors. A master's thesis circulating around the UC Davis campus at the time pointed out that it took 400 pounds of coal tar to make a single ounce of blue dye. Interestingly, the first synthetic dye actually came about by accident.

"William Perkins was looking for a cure for malaria and was using coal tar. He had an explosion in his lab in 1856. All this purple goo landed on the walls. He realized that could actually be [used as] a textile dye ... All of the dyes, ever since then ... are fossil-carbon derived and heavy metal combined. That, in itself, was how we started our industrial dye process.

Of course, things have evolved. There are processes that take the heavy metals out of the dyes. Those are called acid dyes. But at the end of the day, all of the dyes have endocrine disruptors ... [Hormones are] messenger chemicals. If those are scrambled, you can create a lot of subsequent health issues, from cancer to autoimmune diseases, to learning disabilities.

Some people say there are multiple generation impacts ... intergenerational DNA damage ... The peer-reviewed science on endocrine disruption is very clear. We don't know enough about how many parts per trillion, parts per billion or parts per million of these endocrine disruptors are in the textiles when we put them on our skin, because it's just an unknown body of research.

Who's going to pay for that? Not the industry. We have an unknown, but we know we have risks. We have enough science to know there are risks. That's why I'm a proponent of using plant-based dyes."

Can Dyed Clothing Really Affect Your Health?

Today, all cellulosic protein and synthetic fibers such as nylons and polyesters use synthetic azo dyes. Even **organic cotton** T-shirts will use synthetic dyes to obtain the colors pink, green and blue. According to Burgess, up to 70% of the global use of dyes right now are azo, which are among the most hazardous. They contain heavy metals and are very difficult to clean up.

It's rare to find Global Organic Trade Standard (GOTS) certified items. GOTS, which also certifies dyes, is the gold standard certification of organic. It's really the best, most robust certification you can get. While they allow some synthetic materials, including some dyes, they are very strictly regulated.

Now, the fact that synthetic azo dyes are toxic in and of themselves is noncontroversial, but can they actually affect your health when worn on your body, especially after a piece of clothing has been washed a few times?

"That question is something I've been asking for over a decade," Burgess says.

"The science I have found is very dated. I found some research about children who supposedly died from cloth diapers stamped with an ink. The ink penetrated the kidney area of the infant. This science was done in the 1920s. After that, I couldn't find any modern science that showed skin absorption had any toxic effects on the wearer from a synthetic dye ...

The question is how big are the molecules of the dye? Can they get into the skin after washing the clothing? We're washing off what we would call the unbonded molecular components of the dye. The stuff that is bonded to the clothing, does that pose a risk? Can it get into the skin if it's molecularly bonded? These are all questions [that are still] on the table."

In other words, no one is really examining this issue to assess the actual risks. Burgess, who is doing research for a future book on fabric dyes has been posing questions to reproductive health doctors at Mount Sinai and University of California San Francisco (UCSF) who focus much of their attention on chemical influences. According to these experts, chemicals such as those found in dyes do appear to affect pregnant mothers and fetuses in utero.

The impacts can be seen, and the chemicals are known to be in dyes, but questions still remain as to if and how they may enter the body if you wear a dyed garment. Burgess cites an interesting German study showing that even when all known sources of endocrine-disrupting chemicals were eliminated, women still continued to excrete metabolites of endocrine-disrupting chemicals. So, somehow, they were still being exposed to them. Could it be their clothing?

"In the paper, they say, 'One of the exposures we haven't looked at is textiles in clothing and what women are wearing. This is an area for further research.' Who's doing it? We would really like to know, because it's an important thing," Burgess says.

Lint and Dust Could Be a Main Culprit

Interestingly, Burgess believes lint and fabric-derived dust, which can enter your body through inhalation, may be a far greater concern than direct skin absorption.

Considering the many unanswered questions involved, one of the easiest ways to reduce your potential exposure, if you have not yet made the transition to organic clothing colored with plant-based dyes, is to buy textiles that are white or undyed.

Burgess notes:

"Cotton is primarily grown white. Wool is grown white. Most hemp, ramie and linen is bleached with hydrogen peroxide if it's an ecological process or something a little stronger if it's not. But most textile grade fibers end up being white if they don't start that way. That's probably the safest. The [hand-knit sweater] I'm wearing right now is just the color of the sheep."

Now, if one were to assume synthetic chemicals can transfer through the skin, then one of the items of greatest concern would be your undergarments, such as underwear and bras. If you're just now making the transition to organic clothing, replacing your undergarments with a white undyed version would be a good place to start. Ideally, forgo color and buy items that have not been dyed.

Commercializing Vegetable-Based Dyes

Twenty years ago, there were no natural plant-based dyed garments in the commercial marketplace. Even handmade items were typically synthetically dyed. That's now starting to change, albeit slowly. Patagonia issued a tank top and men's shirt dyed with natural dyes. The color of plant-dyed fabrics does differ from those colored with synthetic dye, as plant-based colors are not isolated to a single pigment like synthetic dyes are.

In a plant or vegetable, the pigment consists of a mix of different colors. For example, a plant is not just pink, there are purples and reds mixed in, so the final color is more nuanced and varied than a synthetically dyed piece, where the color will be very saturated and monochrome. As noted by Burgess, "There's a whole spectrum of compounds that create pink. That's why I find natural dyes very beautiful. Patagonia did too."

Eileen Fisher also issued a natural dye line of shirts for women. A Tennessee woman by the name of Sarah Bellos also runs a company called Stony Creek Color that produces Japanese indigo (*Persicaria tinctoria*) on a commercial scale. So, changes are afoot.

The Movement Toward Natural Dyes

Over the past decade, Burgess has done a lot of public outreach, speaking to corporations and giving four to five workshops each month. Most of her career has been focused on teaching people how to make natural dyes as a cultural practice that has a place right next to holistic medicine.

"I would say making these dyes today is almost like making medicinal tea ... Textiles as medicine is part of an Ayurvedic tradition that goes back ... 5,000 years, where wearing turmeric dyed clothes was prescribed to those who had rheumatoid arthritis ... Ayurvedic tradition would prescribe wearing indigo for those who had rigid thinking – [people who had] an inability to perceive a more nuanced or dynamic future for themselves ...

I want to contextualize the value of this work for you. What I would do is share an hourlong presentation on why making this tea is of such great value to personal and global health. [E]ven when I would teach a class at a botanic garden, there were industry leaders there. I would end up running into someone who was a materials designer for Target.

A couple of the women whose husbands were marketing at Patagonia were in my classes. I think word just [got out]. So yeah, I'm a piece of a movement. But I think that it has been rippling out for a little over a decade. This movement began in the '60s and '70s. Natural dye traditions and textile saw a resurgence in that era of counterculture ... It hit again in the early '90s, but it was very commercially focused, not craft focused.

I think what we're doing now is we're synthesizing the work of the commercial movement in the '90s, pre-NAFTA, North American Free Trade Agreement, Organic American Textile Movement. We're synthesizing that with the Craft Movement of the '60s and '70s. I think you're getting this industrial craft bridge now.

You're starting to see people bring artisanship into the bigger industry. How to do that is this ongoing conversation. But there are many of us out there. I wrote a natural dye book in 2009. A lot of my friends have written books since. It's beautiful. In the Northern California region, there are four or five of us who are pretty diligently focused on this work."

Growing Biodynamic Plants for Dyes Helps Improve Soil Quality

Aside from your own health, plant-based dyes also benefit our environment, provided you take it all the way and consider how the plants used for dyes are grown as well. This is precisely what Burgess does. For example, indigo is ideally grown not only according to organic standards but **biodynamic standards**, which are far more comprehensive. Biodynamic farming includes using as many inputs as possible from the farm itself rather than importing inputs.

"[O]ne of my focal points is also no-till agriculture, to protect the microbiome of the soil ... The air pockets in the soil are so important for the health of the microbes. Water-holding capacity is also created by these oxygen pockets. When we turn it up and compact it, when we step on it or when we put a heavy tractor across it, we're creating the conditions for less life.

Less diverse life in the soil means the plants are not getting access to the same micronutrients, because the plant is giving [fungal networks], through root exudates, access to carbohydrates.

These fungal networks eat the root exudates from the plant – taking that as fodder and fuel and going out and getting remote little micropockets of nutrients that might exist miles and miles away from the tree or the plant and bringing these trace minerals back to the plant.

This is what happens in a system that's not using nitrogen fertilizers, which is like fast food for a plant. But when you're really allowing these air pockets, microbes and fungal networks to coexist, you're allowing plants to hold all these micronutrients ... that you don't necessarily get in a system that is tilling soil and using synthetic compounds.

With the natural dyes, I get much stronger dye color from fewer plants if the soil is in this good health, which is porous soil, dynamic and has a lot of microfauna. The same ethics we use for food production around soil health are the same ethics I apply to my textile farming. I don't see textile farming as really much different from food farming, even on the land ...

This is a food fiber textile dye integrative system. A pollinator habitat becomes part of that – hedgerows, where you're planting species of plants that harbor beneficial insects. Polyculture creates so much more productivity and so many different things you can use – medicine, food and dye. I think polycultures are kind of the only way to go for the future."

What Is a Fibershed?

As mentioned, Burgess is the executive director of Fibershed, which is a word Burgess coined. A Fibershed is a strategic geography that allows one to garner, produce, farm, ranch and harvest everything needed for a textile resource base. Fibershed is like a food shed, but for textiles.

It addresses the strategic geography that helps clothe you, because, in fact, it is the land that is responsible for equipping us with what ultimately becomes clothing. At present, about 70% of the fiber in most people's wardrobes is synthetic and fossil-carbon derived.

From a mainstream culture standpoint, we face a major public education effort to educate people about the fact that as we divest from fossil carbon, we also need to rebalance our carbon cycle. "We have to divest not only from fossil carbon and energy systems that are fueling our residential and commercial economy, we have to divest from these modern forms of color," Burgess says, adding:

"We actually have to divest from these modern performance fibers that are made from fossil carbon. They're made from coal tar. We no longer have the capacity to burn fossil carbon. There's just a saturation point from our ocean health and the acidification to 407 ppm of carbon dioxide (CO₂) in our atmosphere. We've burned ancient sunlight. We have to transition.

The organization Fibershed is this intimate idea of 'What is this strategic geography?' It's a very ancient concept. But the idea is to get people to start waking up to land-based fibers. How do we make that transition to these land-based fibers and not rely on genetic engineering or synthetic biology, which are big topics.

I'm really trying to focus people on conservation breeds, resilient heirloom genetics, open pollinated sources of material and focus our land-based systems on strengthening our place-based economies, which to me is a

strategy for climate change amelioration, deacidifying the oceans, healing some of the political divide around urban and rural communities.

Because when you develop a Fibershed, you start to need your farming community and your fashion community to work together. Ranchers and high-end designers partnering, there's a lot of cultural healing that occurs."

The Wardrobe Challenge That Started It All

The Fibershed concept actually began as a one-year wardrobe challenge. Burgess took design school students to farms and ranches raising goats, sheep, alpacas, cows and horses. The farmer and designer worked together to produce one garment from that farm or ranch, which Burgess then wore for one year.

She had it professionally photographed and videotaped so people could see what these urban and rural collaborations were really about. These collaborations and team efforts created a lot of goodwill between the two industries in the process.

"I ran a Kickstarter campaign to raise enough money to help everyone do these research and development projects. Since then, we've seen businesses start. I've had ranchers come to boardrooms for urban brands that are deciding on what their climate strategy is.

A rancher, who wasn't so keen on talking about climate change, came to a boardroom with materials and designs at a major brand, a transnational corporation, and [said] 'Ranching and farming is a heroic process. We can be part of your climate change solution. We are land-based economies. We can sequester carbon. We grow material that we think is going to be of great value to your supply chain.'

They're willing to get on the table and just talk openly about climate change from a rancher's perspective. They're driving to urban communities to talk about this. Because, really, what they want is an economic tie. How to get that wool into that supply chain?

How to get that organic cotton into the supply chain? It opens the doors of perception around ... who you think people are. It just gives you time to be with people. It's pretty powerful, actually. I've seen a lot of transformation."

The Return of Cultural Textile Practices

According to Burgess, we are now seeing the emergence of organic vegetable-based dyes in the commercial textile industry. We still have a long way to go though. She estimates that if we were to replace the current use of synthetic blue pigment with plant-based blue, we would need about 56 million hectares (138.4 million acres) of indigo. That's a lot of indigo to grow. But she also feels we need to have a cultural conversation about how we're consuming color.

Pre-fossil carbon textiles, Europeans wore textiles made from nettle, flax, hemp and sheep's wool. In North Africa and South America, they wore cotton. In India and China, they wore cotton and hemp. All of these materials were undyed and the color of the raw fiber, mostly shades of white and gray.

Sheep's wool has perhaps the greatest variety of color — from black to shades of grey, brown, cream and white. To further alter the color, all you have to do is blend it with nettle, flax or hemp. "You can create really dynamic heathering [effects] by how you spin the fibers together," Burgess says.

"My solution is to just use the color of the material as it comes off the plant and not really add too much more color to that. The last thing I'll have to say about the vegetable matter and how we can increase access to natural dyes [is to use] materials that are on their way to being composted.

Avocado pits make pink. It's beautiful. There's a book called 'Natural Color: Vibrant Plant Dye Projects for Your Home and Wardrobe' by Sasha Duerr. She is an artist I work with ...

Her book has some really nice processes around avocado pit dye. It's been a recipe since the '70s and the '80s as far as I can tell. I just quarter the pit and I

put it in a pot of water. I put a little alkaline, like baking soda or oyster shells and then heat it up to about 180 degrees for half an hour or 45 minutes. That's pre-boiling. That will yield the pink. It'll start coming out of the avocado. Onion skins are another compostable. You could use that."

Looking Toward the Future

Fibershed's vision for the next decade is shared by Regeneration International and other organizations focused on carbon sequestration and environmental restoration through regenerative agriculture.

"We think about [these Fibershed systems] like food sheds and water sheds," Burgess says. "We organize around soil and water availability. We don't engineer nature to do its bidding. We work in harmony with these processes that are in existence. We enhance water holding capacity and dry brittle systems, so that we can produce what we need, even in areas where there's 10 inches or less of rainfall per year ...

Again, I think these natural productive states create local economies. When you have something you can grow, you have something you can eat. You have something you can wear. You have something you can trade ...

I think one of the lenses for doing this work is actually approaching it like we want to create more jobs in rural communities. We want people to feel taken care of and nurtured. We want to be buying things from them and supporting their good work on the land.

I think our work in 10 years is to really see these cultural political bridges built through trading and exchanging, but on the foundation of these restored soils. Through these regenerated social biocultural economies, we then trade with each other from strength, and not from the lowest common denominator – imperial attitude – which is 'I'm going to use this community to produce clothing for me for 10 years.

Until they decide to create a labor union, and then I'm going to throw them over my shoulder like a chicken bone, and then I'm off to Cambodia, and then I'm in Vietnam and then I'm in the Indonesian archipelago.' That's been the textile industry. It just keeps on running to the lowest common denominator and leaving a wake of destruction in its path.

We're trying to reverse that trend of imperial exploitation by focusing on how to work and how to be part of a community that works and labors in a meaningful way, on the land and with each other. Of course, some of us aren't going to work on the land, but we could consume things from the land with an educated mind and a thoughtful way of approaching consumerism."

More Information

To learn more, be sure to pick up a copy of Burgess' bestselling book, "[Harvesting Color: How to Find Plants and Make Natural Dyes](#)." It's definitely one to look at if you have an interest in this topic. Other resources include Kristine Vejar's book, "The Modern Natural Dyer: A Comprehensive Guide to Dyeing Silk, Wool, Linen and Cotton at Home," and Sasha Duerr's book, "The Handbook of Natural Dyes."

On [Fibershed.org](#) you will also find textile research, economic feasibility studies on regenerative agriculture and how to tie the monetary and carbon cycles together – all the work Fibershed has done on land-based economic development. So, if you want to dig deeper into this topic, [Fibershed.org](#) is the place to start. You can also find 140 different independent artists and farmers featured on this website, all of whom are doing this kind of work.