



The marriage of technology and time-honored tradition is helping manufacturers perfect environmentally-friendly, natural textile dyes. Image Source: Unsplash user [drmakete lab](#)

Technological advances have changed the way we live, work, and play. From smartphones to self-driving cars, scientific advances are quickly opening up new possibilities we could not have imagined only a few decades ago. And, yet, despite the proliferation of the man-made and artificial, we are simultaneously witnessing growing interest in a return to time-honored manufacturing using natural materials. In the world of textiles, the trend toward plant-based dyes marks a profound shift in approach and process.

Since the late 1800s, man-made pigmentation sources have eclipsed natural dyes in popularity owing to their ostensibly superior qualities. But as a research cohort from Kumaruguru College of Technology writes the *International Journal for Scientific Research & Development*, “Environment-friendly dyes are recently enjoying a resurgence in popularity because of concerns with the carcinogenic, mutagenic, and sensitizing characteristics of many synthetic dyes.”¹ According to Georgia Kalivas, who teaches in the textile department at the Fashion Institute of Technology, “the byproducts of industrial dyeing include aromatic solvents, formaldehyde, chlorine bleach, and heavy metal salts.”² Not only can these synthetic components affect human health, but they can impact entire ecosystems via [effluent produced by the textile industry](#), leading to significant environmental deterioration. Now, a growing number of manufacturers, big and small, are investigating the use of plant materials to create safe, beautiful dyes.

But the turn towards natural textile dyes doesn’t mean eschewing technology. Rather, a marriage between technology and the natural world is helping to perfect the creation of plant-based pigments and dyeing practices to help them compete with synthetic versions. Spectrophotometers, in particular, are playing a critical role in [guiding researchers and textile manufacturers](#) as they seek to improve environmentally responsible dye quality and performance.



Spectral analysis is playing an instrumental role in exploring and expanding the possibilities of plant-based dyes. Image Source: Unsplash user [Nafinia Putra](#)

Using Spectrophotometry to Expand the Color Palette

One of the primary shortcomings of natural dyes tends to be their limited color palette in comparison to synthetic dyes. In order to make natural textile dyes an attractive alternative to synthetic versions, manufacturers must find dye sources and processing techniques that compensate for this shortcoming.

While there is a broad array of traditional plant-based dyes, their color range and intensity is often not able to compete with man-made pigmentation. Additionally, as natural dyes fell out of favor, much of the knowledge regarding plant-based sources and processes has been lost due to lack of documentation and practice. As such, researchers are now looking to discover and rediscover dye sources that expand the possibilities of natural palettes and achieve a greater intensity of color. Spectral analysis is allowing experts to precisely quantify how different dyes behave and distill color quality to objective data to tailor dye formulations in ways that can approximate the qualities of synthetic dyes. The researchers at Kumaraguru, for example, employed spectrophotometry to investigate the behavior of dyes derived from forest trees to identify absorbance levels and determine how to create the most intense hues through plant-based pigmentation, a significant step toward replacing harmful dyes with eco-friendly versions.

Of course, dyes affect different types of fabrics in different ways; the material that produces a vibrant hue in wools can look muddy in a cotton textile due to the nature of the fibers. As such, it is imperative to [analyze color in the precise textile type or range of textile types](#) for which it is intended. The [sophisticated optical geometries](#) and [integrated height measurement capabilities](#) of modern spectrophotometers ensure accurate color measurement in [all varieties of textile](#) by accounting for variables such as texture and sheen.



The interaction between dyes and mordants can have a significant impact on color levelness and fastness. Image Source: Flickr user [photographerpandora](#)

Evaluating Mordants to Improve Color and Color Fastness

The raw dyes themselves, however, are only one part of the equation. An equally important factor in the creation of natural dyeing processes is the use – or absence – of mordants. As Joan Marks wrote over four decades ago, “Even though the same [dye] formula is repeated, colors vary because different mordants may be used.”³

Mordants are nothing new; they have been used for at least 4,000 years to alter textile color, promote color levelness, and improve color fastness, another traditional weakness of natural dyes. What is new, however, is the use of spectrophotometry to analyze the impact of mordants on various natural dyes and fabrics to optimize color uniformity, intensity, and fastness. In a study published in *Sustainable Chemical Processes* in 2015, for example, researchers employed spectral analysis to discover that “un-mordanted samples dyed in mango and guava leaves extracts showed excellent levelness quality while the un-mordanted ones dyed in henna leaves showed good levelness quality.”⁴ Additionally, “among the mordanted samples the levelness quality was comparatively better in case of alum mordanted dyed samples and the average ΔE value was increased gradually when moved from alum to tin and finally to ferrous sulphate.”

These findings are significant in that the researchers were able to [objectively correlated textile color behavior](#) based on multiple variables to determine best practices for each dye source. Providing reliable, repeatable data allows textile manufacturers to better select their own processing methods to ensure that their fabrics look and perform the way you want them to. This includes not only initial color quality but color fastness and longevity, which can easily be evaluated using spectral data. By

providing a blueprint for the art of natural textile dyeing, it is possible that we will see plant-based dye use supplant synthetic dyes to a meaningful degree in the future, helping to protect both humans and the world around us.

Insert Video: <https://www.youtube.com/watch?v=b5eXxCG99ZM>

HunterLab Innovation

HunterLab has been a leader in the field of spectral analysis for over 60 years. Today, we offer [the highest quality lineup of color measurement tools available](#) to help our customers in the textile industry refine their practices. With a complete range of portable, benchtop, and inline spectrophotometers to choose from, you can easily integrate the objective color analysis at any point in your research and development or manufacturing process. By combining our renowned instruments with our [customizable software packages](#), you can truly take your color quality control protocols to new heights. Contact us to learn more about the possibilities of color measurement and let us help you select the perfect instrument for your purposes.

1. "Extraction of Natural Dyes from Forest Trees and their Application in Textiles", 2013, http://www.academia.edu/6801880/Extraction_of_Natural_Dyes_from_Forest_Trees_and_their_Application_in_Textiles
2. "Colors of the Caldron: A New Generation Discovers Grow-It-Yourself Dyes", April 4, 2012, <http://www.nytimes.com/2012/04/05/garden/a-new-generation-discovers-grow-it-yourself-dyes.html>
3. "Natural Dyes from Plants", November 3, 1979, <http://www.nytimes.com/1974/11/03/archives/natural-dyes-from-plants-natural-dyes-from-nuts-and-leaves.html>
4. "Study on the Color Levelness of Silk Fabric Dyed with Vegetable Dyes", December 2015, <https://link.springer.com/article/10.1186/s40508-015-0038-1>