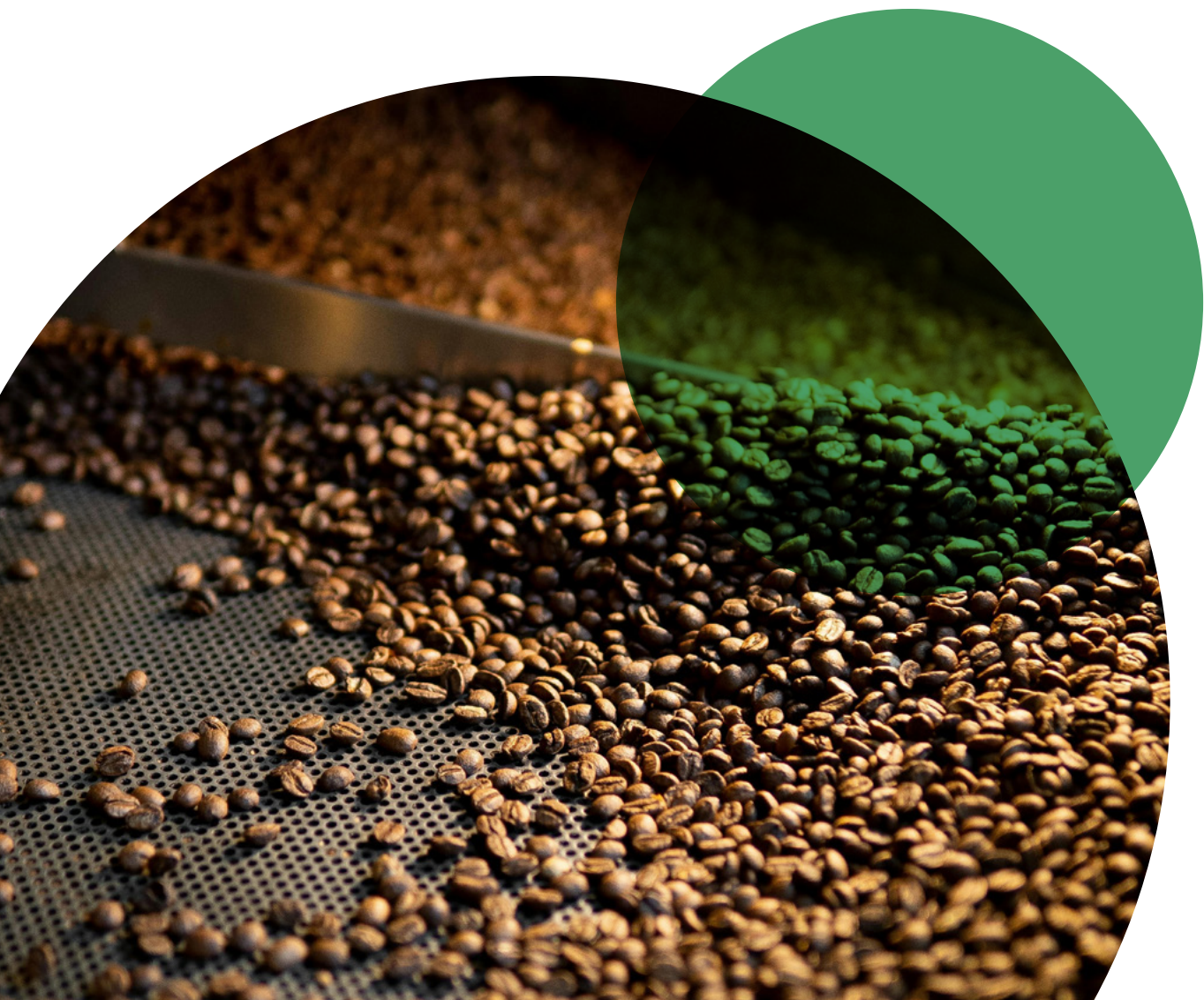


Developing Roast Color Standards for the Specialty Coffee Industry

A New Roast Color
Measurement Approach





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1 Laudia Anokye-Bempah, Tomasz Styczynski, William D. Ristenpart, and Irwin R. Donis-González, "A Universal Color Curve for Roasted Arabica Coffee," *Scientific Reports* 15 (2025): 24192, <https://doi.org/10.1038/s41598-025-06601-w>.

About This White Paper

Purpose

Coffee flavors are developed and revealed by the roasting process. For this reason, the color of roasted coffee is an effective way to predict many important sensory attributes in the cup. Specialty coffee has built much of its identity around carefully profiled roasting, and consumers have learned to connect their flavor and sensory preferences with specific roast colors. However, there is no single, universal system for measuring roast color, nor is there a common language for describing and communicating it.

This inconsistency presents challenges. Because roasters sometimes use different systems to measure the color of their roasted coffee, it can be difficult to communicate details of roast styles within the coffee industry. A common language of roast color would benefit communications within the coffee trade, in research, and in education. Moreover, because of the lack of a universal metric or language to describe roast color, it is challenging for consumers to clearly articulate their roast style preferences, often resulting in confusion or unmet expectations.

This white paper outlines the reasons the Specialty Coffee Association (SCA) intends to adopt a standardized scale for roast level measurement based on visible light measurements. The SCA will invite an expert group to review the draft standard at the end of 2025, with the goal of Standard Development Panel review in 2026.

Relationship to the Specialty Coffee Association's Long-Term Projects

Standards are critically important to the skilled professionals who work within coffee's value system, and they exist to be used by the community to improve coffee quality and establish a common language between buyers and sellers. Given the outsized role roast color plays during the value discovery process for buyers and sellers at all points of the system, it is our view that the SCA can help by standardizing an approach to roast level measurement and creating a structure for roast level designations. In 2020, the Specialty Coffee Association and the Coffee Science Foundation (CSF) adopted a strategy to pursue research on roast color, with the aim of gathering scientifically valid information that could be used by the SCA to develop a standardized technology for roast color and level that could serve the entire sector. In 2022, the Coffee Science Foundation partnered with the UC Davis Coffee Center to analyze and organize data on roast color.²

In 2026, the SCA will undertake several activities to understand how roast color is currently described in different geographies, with a goal of developing a roast color designation standard. Together, the roast color measurement and designation standards would create a common language for roast color, built on a shared, universal measurement system.

2 You can read a plain-language summary of this research at Laudia Anokye-Bempah, Irwin R. Donis-González, and William D. Ristenpart, "What Color Is Your Coffee?" 25, no. 24 (2024), <https://sca.coffee/sca-news/25/issue-21/what-color-is-your-coffee>.

Glossary

Agtron™ Scales. Scales created by the US-based company Agtron Enterprises Inc., designed to measure near infrared reflectance (NIR)—the amount of light reflected off a coffee sample.³

Attributes(s). A property that is characteristic of something; a product (or coffee) can be thought of as a collection of attributes. Well-defined attributes can be identified and quantified using a variety of methods.

CIE L*a*b* Color Space (CIELAB). A three-dimensional color space, created in 1976 by the International Commission on Illumination (CIE), for precisely measuring and comparing all perceptible colors utilizing three color values. In this color space, numerical differences between values represent the degree of color change humans can perceive. Any point in the color space may be represented by three coordinates, where L* is the luminance, and a* and b* indicate the sample's chromaticity (hue and chroma).⁴

Near-Infrared Reflection (NIR). An invisible section of the electromagnetic spectrum with wavelengths between about 780 to 2,500 nanometers.⁵

Sensory Attributes. Intrinsic attributes of a coffee perceived sensorially (i.e., through smell, taste, sight, and touch) by the drinker, including fragrance/aroma, flavor, aftertaste, acidity, sweetness, and mouthfeel. They can be assessed using different kinds of sensory tests: discriminative, descriptive, and affective tests.

Specialty Coffee. A coffee or coffee experience which is recognized for its distinctive attributes, and because of these attributes, has significant extra value in the market place.⁶

Visible Light. The segment of the electromagnetic spectrum that the human eye can view, typically wavelengths from 380 to 700 nanometers.⁷

3 Anokye-Bempah, Styczynski, Ristenpart, and Donis-González, "A Universal Color Curve for Roasted Arabica Coffee."

4 R. W. G. Hunt, R. W. G. and W. G. Robert, *Measuring Colour* (John Wiley & Sons, 2011).

5 Norman B. Colthup, "Infrared Spectroscopy," in *Encyclopedia of Physical Science and Technology* (Third Edition), ed. Robert A. Meyers, (Academic Press, 2003), 793-816, <https://doi.org/10.1016/B0-12-227410-5/00340-9>.

6 Specialty Coffee Association (SCA), *Towards a New Definition of Specialty Coffee* (2021), [sca.coffee/sca-news/just-released-new-sca-white-paper-towards-a-definition-of-specialty-coffee](https://www.sca.coffee/sca-news/just-released-new-sca-white-paper-towards-a-definition-of-specialty-coffee).

7 "What is the visible light spectrum?" NASA Science, https://science.nasa.gov/ems/09_visiblelight/.

Introduction: A Brief History of Roast Color Measurement

For hundreds of years, we have known that roasting alters the coffee bean, developing desirable flavors, aromas, and a range of characteristic colors. As the coffee sector began to differentiate between different roast levels and associate roast levels with coffee's sensory characteristics, a language began to develop to describe roasted coffee's color. By the 1920s in the United States, coffee writer William Ukers described eight roast colors: light, cinnamon, medium, high, city, full city, French, and Italian.⁸ Different countries, of course, had other names for roast levels—for example, Italian roast names included *bionda* (blonde), *continentale* (continental), *intensa* (intense), and *spinta* (pushed).⁹ Though these roast levels were known to the coffee trade, they were rarely communicated to consumers: coffee packages did not routinely specify the roast level of the coffee they contained.

This changed during the specialty coffee movement of the 1960s and 1970s. Early specialty coffee roasters like Peet's in the United States advocated for specific roast colors. Terms like "French Roast" and "Italian Roast" began to be used by specialty coffee companies to help describe their coffee and distinguish it from supermarket "commodity" coffee brands, which did not specify roast level. As the specialty coffee sector developed, various companies developed various styles of roasting, depending on their own preferences and philosophies. Since there were no specific standards to describe the styles and levels of roasting, confusion began to emerge.

In the late 1990s, the Specialty Coffee Association of America (SCAA) attempted to address this confusion by adopting a proprietary set of coffee roasting scales developed by a US-based company named Agtron Enterprises Inc. These scales, which Agtron™ named "gourmet" and "commercial," were designed to measure near infrared reflectance—the amount of light reflected off a coffee sample. The Agtron™ Gourmet scale became the standard of the Specialty Coffee Association, and numerous other companies have developed competing roast measurement devices and scales. Some of these roast analyzers also base their measurements on near infrared reflectance, but use different scales to report the reflected light as "roast level."

⁸ William Ukers, *All About Coffee* (New York: The Tea and Coffee Trade Journal Company, 1922), 388.

⁹ Riccardo Falsoni, *Un mondo di caffè: dalla storia alla degustazione* (Milan: Mondadori, 2013), 90.

The Role of Roast Color in Value Discovery

Measuring Roast Color is Important to Understanding Sensory Characteristics

Exposure to high heat dramatically changes the chemistry of the coffee bean, including through a series of reactions known as Maillard reactions. This process occurs in many foods, such as baked bread, roasted meat, and roasted cocoa,¹⁰ and is commonly known as a “browning reaction” because it contributes to color change. Since Maillard reactions produce brown pigments at the same time as they form flavor compounds, the overall degree of brown color of the roasted coffee correlates strongly with the development of coffee flavor. Additionally, as coffee material begins to carbonize, the roasting process creates other, dark-colored compounds.

Evidence shows that a coffee's roast degree has a greater impact on coffee flavor than other variables, meaning that measuring color is an effective way to predict the flavor of a coffee.^{11,12} Measuring roast color can help coffee roasters and coffee drinkers understand the chemical processes that have occurred in roasting. For example, the roasting process both degrades and creates acids, leading to differences in acid composition across light, medium, and dark roasts. These acids contribute to the overall acidity and the flavor of the final coffee.¹³ Other aspects of a coffee's sensory profile are also affected by roasting: beyond certain thresholds, darker roasting color is associated with reduced sweetness, increased bitterness, and reduced fruitiness. For these reasons, it has long been known that roast color is a reliable indicator of overall coffee flavor.¹⁴

10 Stefan Schenker and Trish Rothgeb, in *The Craft and Science of Coffee*, ed. Britta Folmer (London: Academic Press, 2017), 253.

11 Natnicha Bhumiratana, Koushik Adhikari, and Edgar Chambers, “Evolution of Sensory Aroma Attributes from Coffee Beans to Brewed Coffee,” *LWT – Food Science and Technology* 44, no. 10 (2011): 2185–2192.

12 Scott C. Frost, William D. Ristenpart, and Jean-Xavier Guinard, “Effects of Brew Strength, Brew Yield, and Roast on the Sensory Quality of Drip Brewed Coffee,” *Journal of Food Science* 85 (2020): 2530–2543, <https://doi.org/10.1111/1750-3841.15326>.

13 Shelby E. Yeager, Madison E. Batali, Jean-Xavier Guinard, and William D. Ristenpart, “Acids in Coffee: A Review of Sensory Measurements and Meta-Analysis of Chemical Composition,” *Critical Reviews in Food Science and Nutrition* 63, no. 8 (2021): 1010–1036, <https://doi.org/10.1080/10408398.2021.1957767>.

14 Stefan Schenker and Trish Rothgeb, p.246.

Roast Color is Important to Consumers

Research shows that roast color substantially influences consumer purchase decisions. The US National Coffee Association's 2025 National Coffee Data Trends survey of US consumers stated that, "in 2024, roast level continues to be the most motivating claim to purchase" among specialty coffee consumers—more important than claims like "single-origin" or "100% Arabica beans."¹⁵ The same report noted that 70% of consumers said they were "much" or "somewhat" more likely to buy a coffee with a specified roast level in 2023 and 2024, a small increase from 68% of consumers in 2019.

Roasters have responded to this consumer demand, and today, many specialty roasters include roast color information on their labels. However, this information is not standardized, with different retailers using different systems to describe roast color and roast degree, creating potential customer confusion. For instance, roaster's "medium roast" may be identical to another's "dark roast," resulting in consumer frustration and undermining retailers' ability to match consumers with coffees that suit their preferences.

¹⁵ National Coffee Association, *National Coffee Data Trends: Specialty Coffee Breakout Report 2025*, <https://sca.coffee/sca-news/2025-national-coffee-data-trends-report-available>.

Roast Color Measurement Approaches

Today, there are two main methods to measure roast color, and both detect light that is reflected off a sample of the coffee. The main difference between these two methods is the wavelengths the methods focus on: either selected wavelengths in the invisible “near infrared” spectrum, or the entire spectrum of visible light.

Near-Infrared Measurement

One way to characterize roast level is to measure the reflectance of certain wavelengths of near-infrared light. Near infrared reflectance (NIR) refers to the invisible portion of the electromagnetic spectrum with wavelengths between about 780 to 2500 nanometers. Light in these wavelengths can have certain properties that make it useful for astronomical, agricultural, chemical, and medical applications. For this reason, NIR spectroscopy (NIRS) has become a well-established way to measure such things as grain quality, fruit ripeness, and soil chemistry. Near infrared reflectance (NIR) can also be used to characterize the roast level of coffee¹⁶ and is the basis of the Agtron™ system adopted by the SCA(A) in 1990. One benefit of using NIRS is that it is effective at measuring chemical constituents and can therefore be used to measure specific compounds and ingredients in a sample. Also, NIRS can penetrate the surface of coffee.

However, because NIRS does not measure visible light, it is not able to measure roast color, i.e., the visible appearance of color to human eyes. Some NIRS measurements have been shown to correlate with roast color, but this is not straightforward. NIRS measurements should not be called roast color measurements for this reason. Furthermore, because the temperature of a physical body (such as a coffee bean, or ground coffee particle) is highly correlated with its infrared radiation, NIRS is temperature-dependent, meaning that slight temperature shifts in the sample can result in different readings.

Visible Light Measurement

Another way to measure roast degree is to characterize its color. A common technique is to base color measurement on the way humans perceive color. Since humans have three types of light-sensing cones in their eyes, tristimulus colorimeter devices base their measurements on so-called “tristimulus” values: the intensity of red, green, and blue colors. There are various ways to express these values, but a common one is to use a multidimensional “color space” to illustrate color values in a systematic way.

¹⁶ Laura Alessandrini, Santina Romani, Giangetano Pinnavaia, and Marco Dalla Rosa, “Near Infrared Spectroscopy: An Analytical Tool to Predict Coffee Roasting Degree,” *Analytica Chimica Acta* 625, no. 1 (2008): 95–102.

The CIELAB color space was established by the International Commission on Illumination (CIE) in 1976 as an international standard to express color value. One benefit of measuring color in this way is that it is very relevant to human perception: it is based on the way humans detect and characterize color. Another benefit is that the CIELAB color space is a broadly accepted international color standard, embraced by science and in industries including photography, packaging, and food. Finally, color-detecting photo sensors have become very common and inexpensive, including in many phone cameras.

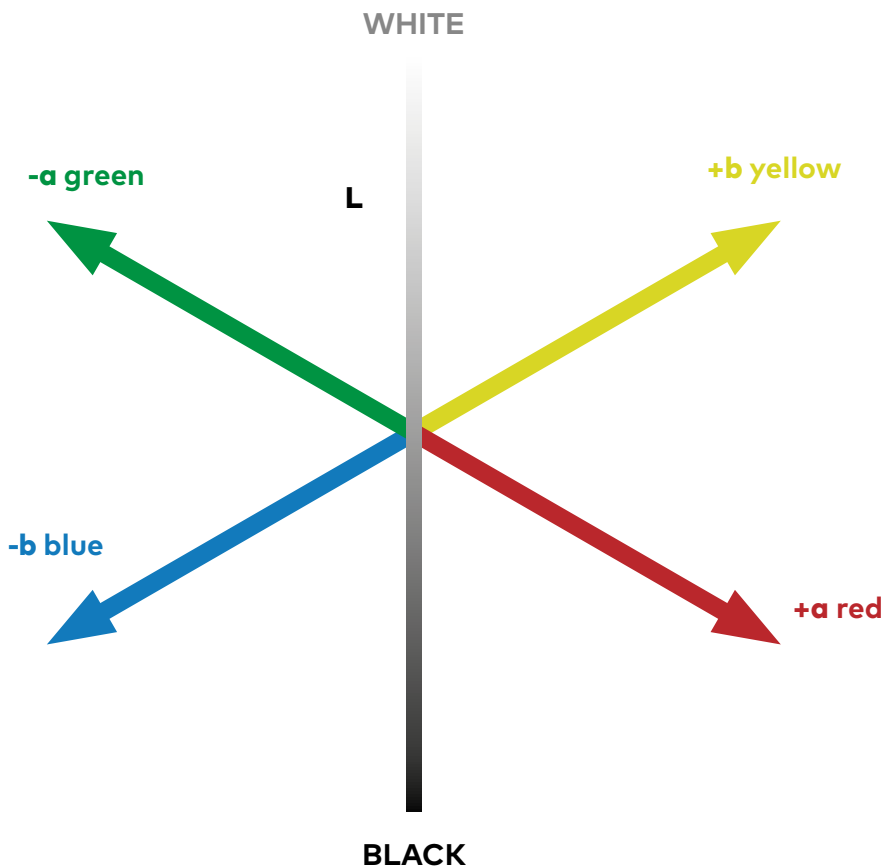


Figure 1: An illustration of the CIELAB color space in three dimensions. Figure created by One Darnley Road, using information supplied by the University of California Davis Coffee Center.

Furthermore, the CIELAB color space has proven to be an effective method of measuring coffee color. To date, over 40 scientific studies on coffee have used the CIELAB space to characterize coffee color. Surprisingly and encouragingly, recent research suggests the existence of a “universal coffee color curve.” This means that regardless of coffee origin, process, and roasting technique, that roast color (measured using CIELAB) progresses consistently from tan to brown to black.¹⁷ The existence of this universal color curve suggests that roast color is a consistent and robust way to characterize coffee development, and that color is comparable across different types of coffees.

¹⁷ Anokye-Bempah, L., Styczynski, T., Ristenpart, W.D. et al. “A Universal Color Curve for Roasted Arabica Coffee,” *Sci Rep* 15, 24192 (2025). <https://doi.org/10.1038/s41598-025-06601-w>.

A New Roast Color Measurement Standard

Roast color has been shown to be important in predicting a coffee's flavor. In addition, roast color has shown to be a valuable attribute to consumers and is therefore a large part of what makes a coffee "specialty." It is therefore desirable for the specialty coffee industry to develop a common language of coffee roast color based on a standardized method of measurement. A common language of coffee roast color would enable consumers to better understand their coffee's flavor, enable roasters to better satisfy customer desires, and reduce consumer frustration and confusion.

Over the past 20 years, light measurement devices have become much cheaper and more accessible. Today, many individuals carry a sophisticated light sensing device in their pocket, attached to a powerful computer (a digital phone with a camera), and purpose-made coffee color meters are popular and inexpensive.

The specialty coffee industry would benefit from a non-proprietary coffee roast measurement system that is usable in multiple contexts—from communicating a desired roast color for samples in a supply chain, to clearly labelling retail bags for consumers.

For these reasons, the SCA has developed a draft coffee roast measurement standard based on visible light (CIELAB) and will introduce it to an expert group in 2025 and the Standards Development Panel in early 2026. This will provide an effective visible-light color-based measurement system available freely to the specialty coffee community.

In 2026, the SCA will embark on a project to understand and standardize roast color naming conventions, so that communication within the roasting community and to consumers can be as clear and as useful as possible.



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