FOOD INDUSTRY COLOR CONTROL

THE COLOR OF QUALITY

When it comes to food, color and appearance are the most important first impressions, even before one's olfactory sense is tickled with a pleasing aroma.

This point is illustrated in the famous Dr. Seuss book, *Green Eggs and Ham*, loved by children and adults alike. Throughout the book, the relentless character, Sam-I-Am, pesters a nameless skeptic to taste his green eggs and ham dish. While the lesson from this story is to not reject things just because they look different, it also shows the reality of how resistant consumers are to trying "off colored" foods.

In today's retail world of behind-glass, chilled, frozen, boxed, dried, and plastic wrapped foods, eye appeal is far more important than nose appeal. Both fresh and processed food producers know this well, and are increasingly adopting instrumental color measurement technologies and practices to control color better across a wide range of applications.

Two Principal Color Measurement Techniques

In current food industry practices, two principal color measurement techniques are used: Colorimetry and Spectrophotometry.

Colorimetry is the technique that quantifies color by measuring three primary color components of light seen by the human eye, specifically red, green, and blue (also referred to as "RGB"). This "tristimulus" color measurement provides data on how much of these three components are present in the light reflected (solids) or transmitted (typically liquids) by a food product. Such data may be used, for example, to adjust the color components in a prepared food or beverage recipe to improve "eye appeal," gauge "doneness" in a baked product, and, in fresh foods, to determine factors such as degrees of ripeness and spoilage during shipping, storage, shelf-life, palatability, and disposal cycles. Although there is no strict demarcation line where the benefits of colorimetry in foods ends, it should be recognized that it measures color much the same as the human eye. That is, secondary and tertiary colors such as orange, yellow, violet, tans, browns, etc. are not individually quantifiable. This leaves a variability factor that can hamper the consistent reproduction of a desired color in prepared food products formulated for a specific, consistently produced look.

CR-410 Series Colorimeter

CM-5 Spectrophotometer

Spectrophotometry, a scientific "step up" so to speak, is presently the most precise and accurate technique for the measurement, formulation, and quality control of desired colors in prepared food products. Spectrophotometer instruments measure the spectral reflectance or transmittance of an object across the full spectrum of human visible light wavelengths, 400 nm to 700 nm (nanometers), enabling precise specification of any desired color. Spectrophotometers offer greater specificity, making them the instruments of choice for food product color formulation, specification of standards and tolerances, inter-plant color communication, and color quality control in processing operations.

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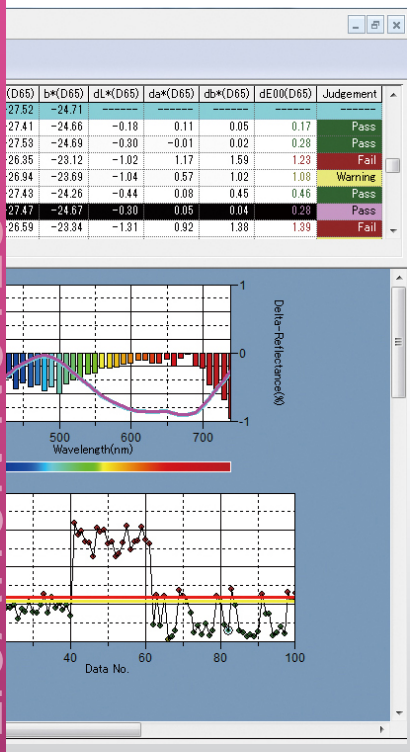
Over the last decade, the use of spectrophotometers in the food industry has significantly increased for color standardization and QC inspection of ingredients, specification of final product color (particularly in jams, jellies, preserves, beverages, etc.), research and development of new food and beverage products, and potential food screening and sorting techniques of factors ranging from carcass natural fat content to quality grading of meats, poultry, and fish.

Software and Methodologies

One indispensable, key factor in the food industry's growing use of colorimetry and spectrophotometry is the availability of easy-to-understand and easy-to-adapt color data software for color measurement, color matching, color formulation, and color quality control. When correlated with all other food laboratory and quality control data, color can become an integral clinical data component of factors ranging from product appeal to shelf-life to possible spoilage and/or contamination risks.

Color formulation software and color matching software packages are available with portable and bench-top spectrophotometers for use in laboratory color control systems. Color quality control software with sample pass/fail comparison testing and database update functions is a standard component of those systems, and is also an integral onboard QC inspection function of our Konica Minolta portable colorimeters and spectrophotometers.

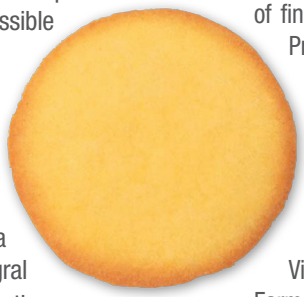


The art in the science of integrating color as a food quality component lies in the methodology developed and used by food producers and the food processors. In food science, technologies are developed in response to needs vocalized by food industry scientists and technologists. In Konica Minolta's Instrument Systems division, we view our role as being technologically responsive: that is, scientists and technologists foresee their color measurement and methodology goals and, in turn, we attempt to create and apply technologies to fulfill those needs. Over the last 20 years, we have moved through nearly four generations of technologies. The following examples demonstrate the continuing advancement of food color measurement, as well as provide hints as to how this technology may progress in the future.

Sample measurement of custards, yogurts, puddings, jellies, jams

Baking "Goodies" at Pepperidge Farm®

Judging baked goods by eye is not as easy as many home bakers might think, according to Mike Davis, Bakery Technologist, at Pepperidge Farm. Until Pepperidge Farm installed BC-10 Baking Contrast Meters, evaluating the acceptable color of finished baked goods on plant floors was a real challenge. Previously, "acceptable color" was established by comparing a production sample against a color photograph of how the product should look when it exits the baking oven. Despite pictures being taken in a special room with carefully controlled lighting conditions, the color on the line was still problematic.



Visual color judgment is simply too subjective. Pepperidge Farm recognized the influence of color and appearance on consumer perception and the flavor profile of baked and fried products. Because of this, a strong focus was placed on incorporating objective standards and measurement techniques into their operations. Portable, hand-held, and battery-powered, the Konica Minolta BC-10 colorimeter eliminated the problem of subjectivity by establishing acceptable color contrast standards (the brightness of a baked or fried product) to communicate numerically to their production plants. Now, color standard and tolerance measurements at Pepperidge Farm are expressed in terms of Baking Contrast Units (BCUs). The Baking Contrast scale is calibrated so that a difference of one-tenth of a BCU corresponds to one perceptible difference in shade as perceived by a normal observer. The BC-10 colorimeter can also report in the commonly used CIE L*a*b* color space and scale units, measuring lightness and darkness in units from the darkest, 0, to the lightest, 100.

BC-10 Baking Contrast Meter

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FOOD INDUSTRY COLOR CONTROL

THE COLOR OF QUALITY

CR-14 Whiteness Meter

"Preserving" the Right Color at Welch's®

A few years ago, Welch Foods, Inc., the famous co-operative of some 1,400 grape growers, was seeking a more pragmatic way of formulating color in recipes for their many bottled and canned juices, jellies, jams, and frozen products. The challenge, their laboratory explained, was the annual, seasonal, and regional variability of the natural grapes used, including Concord Grapes and Niagra Grapes. Grown in five states and a Canadian province and processed in six plants, the grapes varied in a number of factors. Color, of course, is important because many of Welch's products are in clear glass and plastic bottles. Testing samples of each season's harvest against nutritional and recipe standards, an on-going process at the laboratory, was very precise both qualitatively and quantitatively. Color testing, however, was not precise because this was performed subjectively. Working with Konica Minolta's application engineers, Welch's food technologists determined that spectrophotometry was the optimum color measurement and evaluation methodology for them.

Experimenting with portable and bench-top spectrophotometers, the laboratory found that it could work backward from the ideal final product and establish specifications and tolerances for color at each stage of the product manufacturing process. Color variations from standard could then be adjusted to better assure color consistency in final products. Spectrophotometry now plays an important part in Welch's product development.

A Flour by Any Other Name…

One would think that in manufacturing white pasta flour, color wouldn't be much of an issue. Well, with every kitchen becoming a home gourmet's retreat, the surge in specialty flours and the homegrown sprouting of epicurean eyes and palates, it is now an issue - and one to be avoided.

This challenge was presented by a semolina flour manufacturer hoping to determine the best method for standardizing the color of their semolina products for consumer lines as well as commercial products. The problem was natural: semolina wheat grains vary in color. The manufacturer was already combining both grain and flour lots to average the color mixtures, but felt numerical standards and tolerances were needed to assist operations in averaging the ingredients.

The solution was to first standardize an ideal color of semolina flour using a Konica Minolta colorimeter system, and then measure individual flour lots for their color characteristics. By sample averaging, color variability within each lot was reduced, and computer color matching of lots for successful color mixture potential in a final flour blend became possible.

Fresh Mangos in Frozen Maine

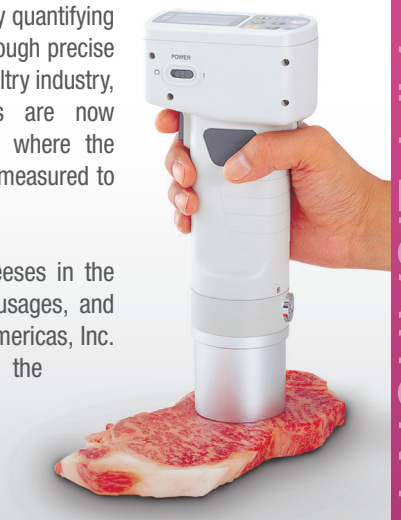
In the 1990's, TransFRESH Corporation, a leader in the development of modified and controlled atmosphere systems for the transport of perishable foods, initiated an advanced program to gauge the maturation and spoilage rates of specific fresh produce items. Creating a controlled atmosphere to keep produce fresh during shipment requires extensive testing. Because of the direct correlation between the ripeness of various fruits and their color, TransFRESH implemented a program using a Konica Minolta colorimeter to chart the ripening process under various controlled atmospheric conditions over typical durations of shipment. For example, the measured color of an avocado rind provided data about its point of ripeness. Similarly, the rate of discoloration of the rind allowed plotting of the maturation process. Today, TransFRESH can precisely determine the right atmosphere needed for a particular product shipment to arrive fresh at its retailer.

Surf, Turf and Barnyard

Since the mid-1990s, Konica Minolta has been working with companies in the seafood, meat, and poultry industries to help them develop and improve color testing and measurement methodologies within their operations. This has included working on a barge in the Pacific Northwest to help a fisheries association establish quality and nutritive content standards of Pacific salmon. To do this, the pink flesh of the salmon was measured using portable and bench-top spectrophotometer systems.

Similarly in the North American beef industry, both colorimetry and spectrophotometry are being tested and used in various ways to classify the fat content of carcasses and cuts both on and off processing lines. This is done by quantifying the relative "marbling" of meat through precise reference to overall color. In the poultry industry, our portable spectrophotometers are now widely used on processing lines where the skin "yellowness" of carcasses is measured to determine fat content.

From ice cream, yogurt, and cheeses in the dairy section to lunch meats, sausages, and sauces, Konica Minolta Sensing Americas, Inc. provides food technologists with the color measurement solutions to ensure favorable "eye appeal" of their final product - a key ingredient to retail success.



Sample measurement of meats, poultry, fish, purees, granules, powders

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