Solving Color Measurement Challenges of the Food Industry

It is easy to understand why color is an important attribute to the food industry. We frequently judge food quality based on color. In the marketplace it is rare that consumers are permitted to taste food products prior to purchasing them. However they frequently can look at the product. They make a judgement decision largely based on overall appearance including color. Frequently color and flavor are directly related. However food processors are often limited in their ability to adjust color in the final product. Because of this, they pay strict attention to the color of ingredients and to the changes that occur during each step of production. Color measurement instruments are used to check ingredient color and to evaluate the efficiency of processes in obtaining or maintaining the desired product color.

Color measurements are also made for other purposes. These include:

- Quality index measurement of raw and processed food for use in quality control, documentation, and communication.
- Determination of conformity of food quality to specification.
- Analysis of quality change as a result of food processing, storage, and other factors.

Color measurement systems are used to measure a broad range of food products. These include both fresh and processed fruits and vegetables, formulated or compounded foods, dairy products, meats and meat products (including fish and poultry), spices and flavors, cereals and grains, oils, syrups, sugar and beverages.

There are many benefits to the quantitative measurement of food color including:

- Improved supplier/customer communications
- Consistent color product
- Improved product flavor
- Reduced waste
- Uniform product density
- Consistent package content
- Improved customer satisfaction

The use of color instrumentation for measurement of fresh fruit and vegetables is quite extensive. One application is the determination of tomato color index. Instrumental measurement of color using the tomato index is being used widely in the tomato canning industry to evaluate color quality of fruit brought to the cannery by farmers. This tomato color value is the numerical value that in part determines the price that the farmer receives for his product. Similar color index scales are used to evaluate processed tomato juice, ketchup, soup, paste and puree. Index scales can be used to evaluate other types of food products. A specific citrus redness, yellowness and equivalent color score has been developed to evaluate the color of reconstituted frozen orange juice.

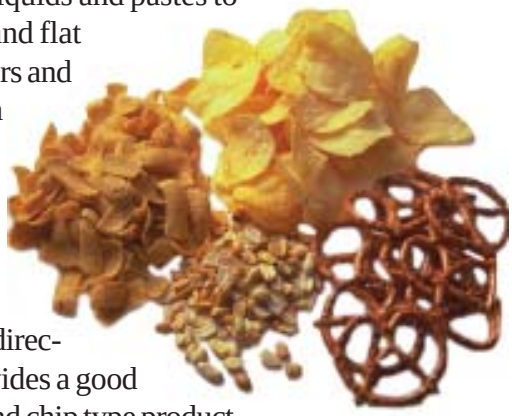
For many products the same heating that is necessary to process and preserve the product will also damage the product if time and temperature are not kept to the minimum required for preservation. Here color is used not only in evaluating ingredients, but to evaluate the cooking or baking process and its effect on the final product color.

It is also important to be aware of product color change during transport, storage, and at the retail site.

Unlike any other industry, the food industry provides an almost infinite variety of product shapes, textures and optical characteristics. For this reason, methods and instruments for color measurement are selected based on the optical characteristics of the food product.

- **Opaque Food -** These are seen wholly by reflected light and include such foods as fruit, crackers, corn flakes, cheese puffs, flour, tomato juice, cheese and meat.
- **Translucent Food –** These are seen partially by reflected and partially by transmitted light. Many fruit juices, jams, and custards fall into this category.
- **Transparent Food –** Clear juices, wines, jellies, gelatins, vegetable oil and soft drinks are some examples of foods in this category.

The form, texture and shape of **opaque food** can range from liquids and pastes to solid forms like powder, granular, flake, chip, disk, cylinder, and flat slab. The best system to measure opaque liquids, pastes, powders and small granules is a 45º/0ºgeometry instrument with a 25mm–50mm horizontal sample port. The sample is simply poured into a sample cup and placed over the instrument port for measurement. When measuring coarse granules, flakes, chips, and disks (i.e. cookies and crackers) the best system is a 45º/0ºgeometry instrument with circumferential illumination and a very large (greater than 90mm) measurement port. This geometry compensates for the directional effect of the sample and the large measurement area provides a good optical average of the nonuniform sample. For granular, flake and chip type product the sample is poured into a large sample cup and measured.



For disk shaped product such as cookies or crackers, the sample would be placed flat across the large sample cup base and a few layers built up, overlapping the gaps left by the previous layer. In both cases, for maximum precision, it is recommended that measurements be made for a few reloads of the sample and the results averaged. For a cylindrical shaped sample such as sausage, the best instrument would have a variable measurement area and a range of measurement port apertures such that the curved side of the sample would completely fill the port. For flat slab samples such as blocks of cheese or slices of meat a horizontal, 25mm–50mm sample port, 45º/0º geometry instrument would work well. The sample would be placed directly on the measurement port aperture. For some samples of this type it is recommended to use a sample aperture with glass insert to prevent juices from dripping into the instrument.

Translucent foods are typically in liquid or semi-solid form. Fruit juice, yogurt and salad dressing are a few examples. Translucent samples require special handling when being evaluated. The color of a translucent sample will change when the light path length through it is changed. Thus the path length must be fixed. Since a portion of the incident light will travel through the sample, its background must be constant and, ideally white. HunterLab has developed a "Ring and Disk" assembly to measure this type of sample. A 10mm black ring is inserted into the sample cup. The cup is then filled with sample. A white ceramic disk is then pushed down through the sample until it rests on top of the black disk. This will give a constant light path and white background. The cup with sample is then placed on the instrument port for measurement.

Like translucent food, **transparent food** is typically in liquid or semi-solid form. However in this case the sample is measured by transmission instead of reflection. Products such as clear juice, soft drink, vegetable oil, and brewed tea are poured into a transmission cell, typically having a path length of 10mm or 20mm. In the case of jelly and gelatin the sample is pressed into the cell such that there are no voids or air bubbles. The cell with sample is then placed in the transmission compartment of an instrument having sphere geometry (d/8º), placing the cell against the sphere port. Most instruments with this geometry also have the ability to measure transmission haze as well as color. This haze value is frequently related to turbidity for products such as clear juice and brewed tea.

In October, 1952, Hunter Associates Laboratory was founded by Richard S. Hunter, a veteran of 25 years in the color and appearance industry. His original vision was to form a development, testing, and consulting group devoted exclusively to appearance and related optical properties of materials. Over the next 54 years HunterLab grew to become one of the worlds largest suppliers of color measurement systems. From the beginning, meeting the needs of the food industry was an important development area for HunterLab. Today all of the top food companies in the United States use HunterLab instrumentation.

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