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| **Maintaining Vigilance Over Quality**  **October 1998 -- QA/QC**  **By: Carol J. Vandell Contributing Editor**  **W**ith greater emphasis being placed on the food industry to provide safe and nutritious foods, it's become increasingly important to monitor those products from the beginning of the production phase, to storage and handling, and finally to the consumer.   Hazard Analysis Critical Control Points (HACCP) implementation has become important to most facets of food production, whether involving meats, eggs, vegetables, beverages or processed foods. Also, more companies require that new suppliers and co-packers go through vendor certification programs. Therefore, chemical, microbial and physical testing of products should be conducted throughout production. The finished product should be tracked and monitored during storage and transit to ensure it is sold to consumers at its peak quality.    Many instruments and systems help food companies keep track of product quality. Much of the collected data can be downloaded into computer-generated reports where technicians can spot small problems before they become big problems, and adjust things accordingly. This ultimately saves time and money should a company need to reject or recall large amounts of product.  ***Gauging color***    A product's appearance greatly influences its salability. If a product's color is faded or dull, a consumer might interpret this as a sign of excessive age. If a bakery item is darker than normal, consumers might think it's been overbaked. These initial impressions can either make or break a sale, so it's important to include measurements for color as part of a product-testing program, as these objective measurements will help quantify the color variances and differences.    A specific color can be measured numerically by creating a three-dimensional coordinate system scale for hue (red, yellow, green, blue, etc. that form the color wheel), lightness (brightness or darkness), and saturation (vivid or dull colors). The assigned values, L\*a\*b\*, view color in a similar manner to which the human eye sees color, with L\* measuring light-to-dark color components, a\* measuring the red-green scale, and b\* measuring the yellow-blue scale. L\*a\*b\* values are calculated from the tristimulus values (X, Y, Z), which are the backbone of all color mathematical models. The location of a color in the color space is defined by these values.    Color difference meters. This type of meter typically measures the color of a product on a specific scale to ensure a consistent product appearance time after time. For example, Minolta Corporation, Ramsey, NJ, manufactures a baking contrast meter (model BC-10) that measures the color of baked, fried and processed foods, as well as ingredients. This meter uses a scale of 0.01 to 5.25, the lowest reading being raw product, and the highest reading being a dark product. Personnel who use this type of meter need to define an acceptable scale number for their product and use this as a standard. All further samples taken are compared with the standard reading and determined acceptable or unacceptable. This type of instrument also can be used as a processing tool for new products - determining shades of lightness/darkness concerning bake or fry time and what temperature settings to use.    Colorimeters. This type of instrument looks at a sample as it appears under daylight by using a pulsed xenon arc lamp that provides constant output for each reading. The lamp illuminates test samples and the light reflected back from the test surface is color-analyzed to give an L\*a\*b\* reading. The reading will tell how much the sample differs from the standard. However, it doesn't provide detail-specific information that would help the analyst determine how to correct color problems. Colorimeters are commonly used to help QA personnel determine if a product is out of the color specification range. Researchers use it to track color changes of product over time. This type of information is valuable because it provides packaging and storage information that leads to process improvements.    Spectrophotometers. Spectrophotometers can look at a sample under 11 different illuminants. You can look at an object and determine the way the color will look under daylight, fluorescent, cool white, to northern sky light. It will then give the color readings in various color spaces and also will provide the spectral curves. "A spectrophotometer gives you the most absolute measurement as far as accuracy and repeatability are concerned," says Maria Repici, marketing manager, Minolta Corporation. "If you want to get the same color time after time, and you want to be able to match that color or re-create that color, and if you have very strict parameters or tolerances that you're meeting in order to control the color, you would want to use the spectrophotometer." She also emphasized the importance of using spectrophotometers that have a high degree of inter-instrument agreement when you have manufacturing facilities worldwide. This would provide absolute color-matching within the company to provide a consistent product.  ***Online inspection***    Some valuable tools for building quality are online inspection systems, which range from metal detectors and X-ray units to machine vision systems, to name only a few. These machines replace the subjective judgments of human inspectors with the objectivity of machines. They have the ability to examine large quantities of product at high speed to detect rejects. They also have high sensitivity levels, so they reject only the predetermined defective product, which generally results in greater yield of acceptable product.    Metal detectors. The internal workings of metal detectors now employ sophisticated technologies, such as digital signal processing to quickly differentiate the signals of conductive foodstuffs from that of ferrous (iron, tin, steel), nonferrous (aluminum, lead, copper), and stainless steel metal contamination. Ferrous contamination is magnetic as well as a good electrical conductor. Nonferrous metals are nonmagnetic, but serve as good electrical conductors. Both of these categories are easy to detect. Stainless steel presents a problem because some grades are magnetic and other grades are not. This limits the metal detector's sensitivity when trying to detect this type of metal.    Metal detectors are comprised of two parts, the electronics and the search head. The search head inspects the product as it passes through the aperture, where it is subjected to an oscillating electromagnetic field called the "search field." A coil arrangement inside the search field is electrically balanced and connected with a combined output of zero. When a magnetic or conductive object passes into the search field, the net output is greater than zero, and the product is rejected.    "Ninety-five percent of metal detection is done on the individual product rather than on the case," says Scott Patterson, vice president, marketing, Cintex of America Inc., Kenosha, WI. "The smaller the distance that the aperture is from the product being tested, the greater the sensitivity will be.    "When checking full cases, the height adjustment needed to accommodate the box enlarges the aperture, which makes the machine less sensitive," Patterson says. "Also, many times, corrugate boxes are made from recycled materials which contain trace pieces of metal. This will cause the machine to reject the box, when the contamination is actually coming from the box and not from the actual product."    A system also exists that will allow metal detection when the foods are packaged in foil bags, aluminum trays or aluminum pans. The unit works identically to the standard metal detection, although the detection field is set up to disregard nonferrous and stainless-steel contamination. This is achieved by using a direct current signal that has a very low frequency.    X-ray machines. These machines can be used to detect contaminated (with rocks, glass, plastic, metals and bone), missing and even misaligned package contents directly on the production line. They scan the product with X-ray. If the contents do not conform to pre-determined standards, the product can be removed either manually or automatically with the use of rejection jets.    Machine vision systems. Processors of french fries, raisins and other fruits, vegetables, cereals and candy are reaping tremendous benefits from machine vision technology, which improves quality, consistency, yield and efficiency by sorting and removing defective products from the continuous product stream. "The machine vision industry has gotten more sophisticated. As the food-processing industry became more sophisticated, the demand for increased performance has driven our technology," says Karen McQueen, marketing communications manager, SRC Vision, Inc., Medford, OR.    Machine vision systems are able to target obvious defects (such as unwrapped candy or burnt, discolored product) or otherwise undetectable defects (such as fruit pits or embedded stems in raisins) faster and more consistently than human sorting. They do this by combining camera technology with customer-specific, product-illumination lamps that will fit their application, and integrating this with intuitive computer software. Once the computer has identified and selected articles as defective, either by color, shape or size, they are automatically ejected in-flight by precise jets of filtered, compressed air. High-speed, black-and-white scanning cameras are typically used for products in which the color of the defect is dramatically different from the acceptable color of the product, such as with french fries. High-speed, color-scanning cameras are used when the defect is a similar hue or color to the product being monitored, such as with string beans where the stem and the bean are basically the same color. Defect levels need to be established by the food processor as this will critically affect their product yield. There are system-compatible analytical machines available to use for analyzing production data.  ***Taking the temperature***    Time and temperature represent two critical factors in the fight against pathogenic microorganisms that can contaminate a food product being produced, transported or stored. In fact, monitoring and recording temperatures during heating, cooling, transportation and storage is crucial in certifying that foodstuffs have been handled in accordance with HACCP standards. Tracing of temperatures using electronic means protects the consumer and the industry. It is a QA tool that should become an integral part of a company's total QC plan. Instruments available are rugged, often portable, tamper-proof, waterproof, affordable and easy to use, and can interface with software for easy downloading of data. They can be programmed to take temperatures at certain intervals, sound alarms or change color when out-of-range conditions occur, and keep a permanent record of the temperature conditions.    Data loggers. These devices can take continuous temperature readings at various points during processing, storage and shipment. One such device, the TempTale unit available from Sensitech Inc., Beverly, MA, can be secured onto a pallet of goods, or to the interior wall of a truck at the start of a trip, and removed when the goods reach their final destination. Temperature information then can be downloaded and analyzed to determine whether the shipment stayed within prescribed temperature ranges. Shipments can be accepted or denied based on the data obtained. Also, data loggers are available that can be used in baking ovens, coolers, dryers and freezers. Temperatures can be taken inside an oven, as well as inside product going through those ovens. This information is then downloaded and can be used to solve a variety of QC, maintenance and product development issues.    Time-temperature integrator (TTI) tags. TTI tags incorporate a color indicator with multiple dots that change when temperature or shelf-life requirements have been exceeded. The tags can be matched to the storage requirements of a particular foodstuff, because the color shifts are affected by an enzymatic reaction chosen specifically for that product. The tags can be placed on individual cases or pallets instead of being hung inside of a truck - an important consideration when multiple deliveries are made by one vehicle or when the product is being shipped by multiple modes of transportation.    Handheld noncontact infrared thermometers. All that's needed is to point, shoot and read the temperature. Infrared thermometers feature a laser circle that outlines the spot size being measured at any distance. They offer two key application benefits over conventional thermometers. First, they can be used to replace contact temperature measurement systems, such as probes, that can potentially contaminate the source. Secondly, in large food storage areas, such as walk-in freezers and refrigerators, where a single thermometer is often used to monitor the environment, the infrared thermometer affords the user the ability to spot-check various "targets" for a more complete assessment of temperatures throughout the location. They enable users to take even more readings than usual because they decrease the time it takes when using conventional thermometers.    "The National Environmental and Health Association, along with Raytek Corporation and other infrared manufacturers, is working with legislators in Washington, D.C., regarding regulations that would include spot-checking with infrared," says Michele Reutzel, marketing communications specialist, Raytek Corporation, Santa Cruz, CA. "Infrared thermometers would play a very important part in every HACCP program."    Temperature-indicating labels. Temperature labels permanently record maximum interior or exterior temperatures of products during processing, storage and shipment. They're inexpensive, easy to use, and can be utilized as a permanent temperature record. The labels are formulated to react within a few seconds when the rated temperature is reached. The various single and multi-temperature labels are generally rated within an overall temperature range of 90°F to 500°F (32°C to 260°C). As each section of a label reaches its rated temperature, that section responds with a sharply defined color change from white to black, leaving the printed temperature clearly visible. They can be used in areas such as ovens, curing and sterilizing chambers, ships' holds, as well as inside processed foods. They have a shelf life of two years when stored at room temperature, and come in various temperature ranges.    Remote data loggers. A completely different technology for tracking temperatures of food products during domestic or worldwide transportation and storage is available from Measurement Dynamics L.L.C., West Warwick, RI. Not only are temperature conditions recorded, but the actual physical location of the product is identified, even while the product is in transit. The temperature-recording equipment is linked to communications equipment using global-positioning satellite telemetry. This can locate a shipment anywhere in the world. After determining where the product is, producers can save satellite charges by using cellular phones to download information about what conditions have existed within the cargo box.  ***Water activity***    Water activity (Aw) is equilibrium relative humidity with the decimal point moved two places to the left (example: 100% humidity = Aw 1.00). At the 100% humidity level, water is available at zero tension. Aw is defined as the free, unbound water present in food and food products. It influences bacterial growth, non-enzymatic browning, lipid oxidation, degradation of vitamins, enzymatic reactions, protein denaturation, starch gelatinization and starch retrogradation. This is why it is important to measure a food product's Aw. It provides an idea of how a food system is reacting to the water present in the system (including moisture migration and susceptibility to pathogens). Knowing Aw values also can serve as a valuable tool when determining drying times for dehydrated product and determining product shelf life.    The food sample to be analyzed is put into a sample cup, then put into the meter for reading. The water in the sample diffuses into the atmosphere above the cup, and the water molecules in the atmosphere diffuse into the sample. Eventually, the two systems come to a state of equilibrium, where the diffusion is equal. This point is called equilibrium relative humidity and is used to calculate the Aw of the sample. This reading is generally taken at room temperature, and can range from 0.100 to 1.000. Decagon Devices, Inc., Pullman, WA, manufactures a model that can measure Aw values within five minutes or less by utilizing an internal fan system that speeds up the equilibration time. This is an important advantage when multiple samples need to be analyzed. The company carries a meter that controls the temperature of the sample using a circulating water bath, says Anthony Fontana, Jr., Ph.D., applications engineer, Decagon Devices, Inc. This type of system is used to determine the Aw value at a specific temperature (other than room temperature) to satisfy corporate internal regulations, such as readings at 25°C. It also is useful for temperature studies as well as accelerated shelf-life studies.    In today's environment, it's easy for a good product to go bad. But technology has brought us a wide variety of detection instruments to help keep food products on the straight and narrow.  ***Carol Vandell is a technical writer and food-safety consultant. She has a bachelor's degree in food technology and 11 years experience in the food industry. Her specialties include QA/QC, R&D and food-safety fields.*** |