Objective Color Standards for Pork

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Topic Summary

"Are the current color grading methods adequate for the industry?" Secondly, "will the industry be moving towards more instrument grading systems?" The answers to both of these questions will impact the need for new color standards and their development.

If the industry foresees continued, long-term sorting of carcasses based on subjective evaluation by "experts", then the current subjective standards for assessing pork color should be sufficient. However, if the industry anticipates the need for improved color sorting of carcasses, primals, or even individual cuts of meat, then the obvious result will be implementation of objective color grading systems. These systems will require a tool, or method, to define an industry standard for description of pork color. This standard would then be used to calibrate the on-line, or off-line color grading systems. The development of objective color standards for pork was the topic of this discussion.

Background Information on Color Descriptions

Color is typically described using a three dimensional coordinate system (color space or color scale). Two common systems include: CIE L*a*b* (Figure 1) and RGB (Figure 2). The CIE Lab color space is preferred by those who work with products that have been pigmented or dyed such as paints, textiles, plastics, and so on. This scale is was designed to correlate closely with the manner in which humans perceive color. Red and green are considered opposites (a* scale), and blue and yellow are considered opposites (b* scale). The overall lightness or darkness of the object is determined by the L* axis (0 dark, 100 light).

RGB color space is most commonly used by electronic devices such as cameras, camcorders, TVs, and so on. This scale is designed to correlate closely with the manner in which humans perceive color. Red and green are considered opposites (a* scale), and blue and yellow are considered opposites (b* scale). The overall lightness or darkness of the object is determined by the L* axis (0 dark, 100 light).

What Is an Objective Color Standard?

An "objective" color standard in simplest terms is a reference color or set of colors which are defined in a color coordinate system. Typically a standard identifies all of the parameters which specify the objects and/or affect the measurement procedures as listed above. The Japanese color standards developed by Nakai et al., 1975 is an example of an objective standard. The six color block's coordinates are specified in the Hunter Lab scale (similar to the CIE L*a*b* scale). These standards were also designed to be used under fluorescent daylight lamps. The six colors were equally spaced within the Lab color scale.

The purpose of a set of standards for pork color should be very clear. It should be to serve as a reference for describing the different colors commonly found in raw pork meat. Then, when a color is referred to as matching standard color No. 1, for example, the color coordinates are defined in some color scale. The purpose of a standard should not be to de-
fine the “best” color or to assign an economic value to a particular color.

The characteristic colors of real pork samples (Figure 3), NPPC standards (Figure 4) and Japanese standards (Figure 5) are shown in RGB coordinates as measured with a color vision system.

**Discussion Summary**

The following questions arose regarding the Japanese color standards: Are the coordinates (L, a, and b) in the center or the end of each class? Are they the average of “1” or the extreme of “1”? The only right answer would be to refer directly to the paper describing the standards. Then, comments were made that the Japanese standards “don’t look like pork”. Some information suggests that they may have been based on sow meat.

The next discussion topic regarded the way that humans perceive differences in color. We would like to see the same incremental changes detected by instruments that we see with our eyes, whether in order, linear or not. Where is the line drawn between these color classes (1 through 6)? Do humans perceive the Japanese standards as equally distributed? (the eye perceives data (Color) differently than instrumentation. A comment was made that it is easier to discriminate the lighter colors than the darker colors, i.e. the difference between 1 and 2 is easier for humans to detect than differences between 3 and 4. Are instruments comparable to visual perception? With respect to the above discrimination of colors, yes. It is easier for an instrument to distinguish between two light colors than between two dark colors in RGB space. One participant stated that if standards are developed based on incremental L, a, and b values, the human evaluators will “evolve” along with the new sophistication. The “new generation” of pork evaluators will more than likely subjectively evaluate pork based on ‘this level of L’ or ‘this level a or b’.

The 1991 NPPC standards are pushed beyond what they were intended for. However, the standards are ‘amazingly’ close to actual pork chop color and have a correct distribution of color that is actually occurring within the industry. NPPC is currently updating their color standards. David Meisinger would like to be able to tie the subjective (human visual) assessment with the objective (machine vision) assessment. Do we want to draw distinct lines based on visual pork color where objective meets the subjective. How do we tie these together? Two approaches include: training a machine to perform similar to an expert panel or, train an expert panel to sort similar to quantifiable machine results.

Mark Morgan says that machine vision can draw a diagonal plane in 3-D space to separate the different colors. Has this been done with real chops? Yes-See Figure 3. Using a trained sensory panel, we’ve attempted the first approach above. NPPC standards are not as distinct, not evenly distributed (like Japanese standards), and not exactly diagonal. The panel more closely matched the NPPC distribution. The new standards, then, may not be evenly distributed. Can we standardize a machine to expert panel visual assessment? Yes-The calibration standards will define the spacing between the colors.

The texture of chops (or the Japanese standard blocks) does affect the perception of color. The texture (and the polymer used) of the Japanese color blocks does not have “absorbance” like a pork chop would. Therefore, research at Purdue has found that one cannot measure the Japanese standard with an instrument and then measure pork and make claims based on that comparison. They are not close enough to real pork color to be used effectively by a color vision system.
Other factors which affect human perception of pork color was then discussed. Humans cannot “filter” out marbling which will often attribute a lighter lean score. Color vision systems can “throw out” most marbling. However, it is not perfect. Fat (marbling) below the lean surface will be perceived as lighter colored lean tissue as a result of light penetration. Colorimeters or chromameters can also be affected by marbling since they measure the average reflectance of an area.

Mark Morgan showed the color vision systems method of separating colors by establishing planes of separation. This is a fast algorithm to identify which pixels are separated by planes and how they fall into categories. However, it is only one algorithm for color separation. The result of such an algorithm is to define the percentage of pixels of each color within an image. Typically pork has more than one color of lean within an individual sample. So, how do you set a score based on this (particular) distribution of color?

Other Issues Which Were Discussed

**Lighting.** Proper color, and temperature of light are important. Types of lights include tungsten halogen, incandescent, cool white (fluorescent). The optimal type of light necessary for viewing intra-muscular fat would be different from the optimal light necessary for viewing lean color. It may be necessary to standardize the light for viewing the standards as well as the lean.

**Chromameter calibration.** Should one calibration plate (white) or more be used? The discussion was that as long as you define the system and the calibration criteria, there is no right or wrong way. This will allow for multiple users and multiple systems (however, it was stated that Minolta does not advocate comparing different machines or even the same model of machine used in a different location). It was also mentioned that there may be a color tile that you wish to use because it is similar to the color you are most interested in (Oscar Meyer used to do this). It was recommended that all parameters be documented and individual laboratories should establish their own quality control of their instruments to catch problems as they arise. The white tile will not register to the extreme value of 100 and the same is true for the opposite, black. This sounds like an instrument problem. Secondly, if the meat is sprayed with water (or has excessive drip/purge) this will not affect the L value. True, water is neutral in pigment so color must be added to the measuring surface before it will raise/lower the L value. The wetness of the lean will affect the human eye (human perception) but not necessarily the instrument, unless it affects the angle of reflection of the light, like a glossy surface. Very glossy surfaces will show a speckled reflection and look white in these areas regardless of the underlying color.
Site of Evaluation. Where do we evaluate pork lean? The loin is difficult because it is not ribbed in practice. The current NPPC standards are for the 10th rib and we seldom see this location! We can't evaluate at the shoulder loin separation (3rd rib) as it is often paler PSE-looking while the rest of the loin is normal. Discussion stated that we can apply the established color to any point (any lean) within the carcass. Just establish a standard description for pork lean and apply it wherever needed.

What About Using ‘A’ and ‘B’ Values?

- Could identify an “off” color.
- Early studies say that L value is the best. The a and b values have been poor historically.
- a and b have an angle, chroma/saturation index. i.e. common L value will have a different ‘a’ and a common ‘a’ will probably have different L values.
- Not sure how do ‘a’ and ‘b’ values change down the line i.e. at the retail case.

The unanswered questions: What is the objective standard? What reference coordinates? What is the purpose of a color standard for pork? How many colors are necessary? Color standards that are too close together to be distinguished with the eye indicates there are too many. Also, if you have too few, the categories are too far apart. How do we deal with variation within the sample (i.e. within the loineye)?

Reference

RMC RECIPROCATION SESSION

Methods to Monitor/Quantify Postmortem Changes in Muscle Proteins

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Topic Summary

Postmortem changes that occur in muscle are extremely complex. As the cellular and subcellular environment is altered, muscle proteins undergo very dramatic changes. In order to develop an understanding of the specific changes occurring in postmortem muscle proteins many questions must be asked. In order to answer these questions, numerous different biochemical tools can be used. The choice of which biochemical tools to use depends on the parameter to be measured. Some of the most often monitored postmortem changes include protein denaturation and protein degradation.

Denaturation of protein is defined as any modification of conformation not accompanied by the rupture of peptide bonds involved in primary structure. This can have several consequences including the unmasking of hydrophobic groups which can lead to decreased protein solubility, precipitation of proteins onto myofibrils, loss of the protein’s biological activity, and alteration of the susceptibility of the protein to proteolysis. One method to measure protein denaturation on a relative basis involves monitoring the solubility of muscle protein fractions in buffers of defined ionic strengths. After dispersal of the protein in buffer and centrifugation to pellet insoluble cellular fractions, the protein content of the supernatant is determined. The lower the protein content of the supernatant, the less soluble protein is found in that fraction and the assumption is made that the protein in that fraction is relatively more denatured when compared to samples with a higher protein content in the supernatant.

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