# A NEW LOOK AT BEEF CARCASS EVALUATION PROCEDURES -- QUALITY FACTORS

H. B. CRAIG

NORTH CAROLINA STATE COLLEGE

The term, quality, as it refers to meat includes a number of attributes which motivate the consumer to select certain meat cuts from the retail show case and reject others. When one considers quality, the two attributes that are immediately brought into focus are color and marbling -- and rightly so since these two characteristics can be rapidly appraised visually. Color of meat, while not known to possess any intrinsic value as a part of quality, nevertheless, does have psychological and commercial significance since "desirable" color is associated with freshness and wholesomeness, as well as, animal age.

Therefore, since color and marbling occupy such a prominent position, I would like to confine my remarks to these two factors, paying particular attention to this thing we call marbling.

In an effort to familiarize myself with color evaluation procedures previously reported at this conference, I reviewed the proceedings with the following results: Brady (1949), Wilson (1951), Bray (1951), Brady (1952) and Hall (1954). All mention that the spectrophotometer occupied a rather prominent position as a color measurement tool. Wilson (1951), Brady (1952), Hiner (1954) and Bray (1951) reported that Munsell spinning discs were also rather extensively used. In fact the latter author indicated that as a result of a poll of 47 questionnaires sent to various agencies, 20 of these were using Munsell spinning discs for meat color measurement. However, of this number, only seven were satisfied with the performance of this device.

In addition to the spectrophotometer and Munsell discs, the result of the poll conducted by Bray (1951) indicated that the following devices were also used for color measurement:

Color comparator

Munsell Meat Scale and Color Paddles (I have never seen these and Hiner (1954) states that they could not be obtained from the Munsell Color Company).

Photoelectric cell

Hunter Color and Color Difference Meter

Ostwald Color Chips

Fat Discs - Beall

Kodachrome pictures

Container Corporation Color Charts

The methods of color evaluation outlined above are concerned with the appraisal of meat surface color. If we are to understand the mechanism of color change, which, in the final analysis, is what we must do, then it is necessary to get beyond the superficial and into the basic aspects of meat pigment and factors responsible for its change. Schweigert (1954) states that there is a relationship between the color of beef muscle and its myoglobin although other factors also influence visual color of muscle. Some aspects of pigment extraction and chemistry are also given. Craig et al. (1959), Fleming et al. (1960), Briskey et al. (1960), Ginger et al. (1954), Henry and Bratzler (1960) and other workers have evaluated muscle color by means of its myoglobin content. The work of the former authors indicated that there was reasonably good agreement between Munsell Color notations converted from Hunter Color and Color difference meter readings and myoglobin concentration.

At North Carolina State College we have initiated a study in which we will attempt to explore the physiological and chemical aspects of meat color by determining the relationship between muscle pH, myoglobin, hemoglobin, blood oxygen content and muscle tissue partial pressure of oxygen in beef steers on two exercise levels and two different rations. This is an attempt to get beyond the superficial.

In preparing this paper for presentation, I thought it might be of interest to poll some of our Colleagues in an effort to ascertain the type of research currently being conducted in the area of beef muscle color. Out of 32 requests, I received 10 replies. Of this number four indicated they were working on some aspect of color and a fifth was initiating work in this area. Missouri listed several methods that they had used for color evaluation among which was a subjective panel. I might add that we at North Carolina State also use this method.

Oklahoma reported on the use of a Photovolt Reflectance Meter to obtain Munsell Color notations. Their data indicated that steaks from the Longissimus dorsi muscle become darker red with advancing animal age and tend to be lighter, brighter red after aging 14 days. Of the Three Color Components, Munsell value notation seemed most influenced by color differences since this part of the notation decreased with advancing animal age and increased with increased meat aging time. The value dimension of Munsell Color, as you know, refers to the whiteness or grayness of a color and varies from 10 (white) to 0 (black).

Arkansas also reported on the use of a Photoreflectance Meter to evaluate color. Likewise, their data were converted to Munsell Color notations. Two experiments were conducted. In the first, the effect of limited and full feeding with and without stress (with electric hotshot) on the color of the Longissimus dorsi, Psoas major and Quadriceps femoris was evaluated. Stress significantly altered color as evidenced by Munsell value change in all three muscles in the raw state and of the Psoas major when cooked. As with the Oklahoma work, Munsell value was most influenced by color differences. In another study, Munsell color notations were obtained on cooked and uncooked steaks and correlated with the following panel scores: aroma, flavor, texture, tenderness and juiciness. There was no appreciable relationship between color and any of these taste panel scores.

The Michigan workers have long been interested in meat color and a report from them indicated a study on purified beef myoglobin. Some preliminary work there indicated the existence of at least two, and perhaps several, distinct myoglobin species in beef muscle. Various chromatographic columns were used in the preparation of electrophoretically homogenous myoglobin and in the separation of the electrophoretically distinct myoglobin species. Analysis of iron content, absorption spectra and oxidation rates indicated only slight differences between the purified myoglobins. Another recent study at Michigan involved the effects of certain ions and light of various wavelengths on the color change in frozen myoglobin extracts. Color was measured by means of Munsell spinning discs.

By way of summary remarks, let me make the obvious observation that there are many methods for color evaluation. Some are suitable for certain research undertakings while others are not. The nature of the problem dictates to some degree the method to use. I have often wondered as did Wilson (1951) why we have not arrived at a basic understandable standard method of color measurement or appraisal to use in routine carcass evaluation work. Certain information on color is often difficult to interpret unless one is a color expert; and as a result, considerable research data in this area are all but meaningless.

Now we come to the second quality attribute -- that of Marbling. Generally, I will confine my remarks to a study we have made at North Carolina State College. Let me add, at the outset, that most of this information has been submitted to the Journal of Animal Science for official publication under the title, "Nature and Variability of Marbling Deposits in Longissimus Dorsi Muscle of Beef Carcasses"; and any reference to this work should cite this publication.

For several years at North Carolina, we have used an objective method of measuring marbling developed by Blumer and Fleming (1959). This method has been used on a large number of cattle carcasses. It is designed to measure the area of fat deposits in the Longissimus dorsi muscle in square millimeters. Application of this method to marbling evaluation to determine the effects of various breeding and nutrition experiments failed to produce consistent results. The study reported here was undertaken to determine whether this result was due to variations of marbling content within the rib eye muscle or due to animal variation within treatments.

Marbling was measured on the cut surface of the rib eye muscle of 40 animals at three locations -- anterior to the 13th rib and posterior and anterior to the 12th rib. In one case, a five-fold variation in the amount of marbling was noted and two-fold variations were quite common. The average marbling area (in square mm.) for the 40 cattle was 30 percent greater in the surface cut posterior to the 12th rib as compared to that anterior to the 12th rib.

These observations stimulated additional studies on locational variation in marbling of the Longissimus dorsi muscle. This muscle was removed from the 9th, 10th and 11th rib section of the right side of 22 cattle fed in drylot or pasture and ranging in grade from low standard to low prime. The muscle sections were frozen, sawed into 1/4-inch sections and subsequently scored to the nearest 1/3 USDA marbling grade by three individuals.

In order to more clearly illustrate differences in the degree of marbling within each rib section, the slices considered to have the most, least, finest and coarsest marbling were determined. Ether extracts were then made on each of these four slices. Values were expressed on a fresh and dry weight basis; but since statistical differences were essentially identical for fresh and dry weights, only the fresh weight values were used. Correlation coefficients were determined on each of the four slices with their corresponding ether extract values. Standard deviations were also calculated.

Slide 1 indicates the range in marbling grades over the 3-3½-inch muscle section and the grade placed on the rib eye muscle at the 12th rib.

MARBLING VARIATION

| Cattle No. | Range Marbling Grade | Marbling Grade at 12th rib |
|---|---|---|
| 485 | Sl + to Sm - | Sl ° |
| 482 | Sm ° to Me - | Sm ° |
| 460 | Sl + to Mt - | Sm ° |

Cattle No. 485 doesn't show sufficient marbling variation to be graded out of the good grade; however, No. 460 varies from low good to low choice disregarding conformation. No. 482 varies from about average good to well into the choice grade and all in the same animal. Compare the grades placed on the muscle at the 12th rib. It was noted that more variation occurred in the higher grading animals.

Slide 2 shows the 14 slices obtained from the muscle of Cattle No. 482. Notice, in addition to the quantity variation, the variation in the degree of coarseness. Observe the recurring pattern in fat distribution, that is, several consecutive slices have coarse marbling followed by several that have fine marbling. It was noted that the rib eye muscle section immediately dorsal to the rib bone exhibited coarse marbling; whereas, fine marbling was observed in between the ribs. Obviously, this serves to point out the fallacy of stating that one animal is more finely marbled than another when both conditions can be seen in a single muscle dependent, in large measure, on the location of the cut surface.

Slices 3, 6, 7 and 9 indicate the finest, coarsest, most and least amount of marbling, respectively. Note that slices 7 and 9 are only 1/2 inch apart but exhibit rather large differences in marbling content.

Ether extract values were not determined on these slices, but values obtained from 19 other animals indicated that the most chemical fat was found in the most and coarse categories. Less chemical fat was found in the least-fine categories. In 60 percent of the cases, the slice indicated by the grader to have the coarsest marbling also had the most marbling. Correlations between the marbling scores and ether extract values for least, fine, coarse and most, respectively were as follows: 0.92, 0.92, 0.91 and 0.87. Standard deviations ranged from 0.630 to 2.749 marbling scores. Ether extract values varied from 4.96 percent to 8.90 percent in one animal.

Thus, variation seems to be the rule; and methods for evaluation of differences in marbling content by ether extract or other means and the relation of these to treatment effects and eating quality are not of great value. Since such great variation exists, it appears that we do need to reevaluate our methods. It seems that in order to approach any degree of accuracy in determining ether extract, one should use a rather large sample preferably the muscle section located from midpoint between two ribs to midpoint between the adjacent pair.

Since considerable marbling variation was noted within each muscle, we attempted a further study of this aspect. Twelve steaks cut one or two inches in thickness were removed from the loins of several carcasses. To determine whether or not there was a definite pattern by which intramuscular fat was deposited, all visible marbling deposits on the two exposed surfaces of each steak were carefully dissected free of surrounding muscle tissue. The method of procedure may be more readily discerned by observing Slide 3. Notice the extreme ramification and interconnection of the subsurface marbling branches. Slide 4 shows another view of the intense branching noted in the Longissimus dorsi muscle of the same animal. This dissection procedure indicated a large trunk-like portion of fat to be present in approximately each linear inch of the rib eye muscle. It may thus be discerned as to why there is a variation in coarseness and amount of marbling depending upon the point at which the muscle is cut. A cut through the large branches would result in exposure of a large marbling deposit which would not have been observed at all had the muscle been cut only a few millimeters to the left or right.

Slide 5 shows the result of completely dissecting a large marbling deposit from its position in a rib eye steak. The characteristic marbling pattern seems to consist of tree-like branches seemingly having their origin from fat loci located adjacent to the rib.

The relationship of marbling deposits to the blood vascular system was demonstrated by injecting a solution of India ink into the intercostal branches of the dorsal aorta in the 6th, 7th and 8th rib section of a wholesale rib cut. In Slide 6 a portion of the vascular system within the muscle and the fat may be observed. The darker, upper portion of the slide is muscle; the lighter, lower portion shows the marbling deposits.

In Slide 7 the extreme right hand portion illustrates a small blood vessel exposed in a marbling deposit approximately 3 mm. in diameter. Upon tracing the vascular system, it was found that the main trunks of these marbling deposits appeared to be located close to or within a heavy network of vessels.

The fact that some variation in marbling distribution occurs has been mentioned from time to time in various research undertakings. Many of you have, no doubt, observed this condition. I hope that this discussion has served to make us all more aware of the problems we face when we set out to evaluate the marbling in beef cattle carcasses. Any objective method of marbling measurement must consider the inherent variation that exists in a given rib eye muscle.

## LITERATURE CITED

Blumer, T. N. and H. P. Fleming. 1959. A method for the quantitative estimation of marbling in the beef rib eye muscle. J. Animal Sci. 18:959-963.

Brady, D. E. 1949. Some observations on chemical methods used in meat research. Proc. Second Annual Rec. Meat Conf. 2:99-104.

Brady, D. E. 1952. Physical research methods. Proc. Fifth Annual Rec. Meat Conf. 5:148-155.

Bray, R. W. 1951. Physical and histological phases of meat research. Proc. Fourth Annual Rec. Meat Conf. 4:158-165.

Briskey, E. J., W. G. Hoekstra, R. W. Bray and R. H. Grummer. 1960. A comparison of certain physical and chemical characteristics of eight pork muscles. J. Animal Sci. 19:214-225.

Craig, H. B., T. N. Blumer and E. R. Barrick. 1959. Effect of several combinations of grass and grain in the ration of beef steers on the color characteristics of lean and fat. J. Animal Sci. 18:241-248.

Fleming, H. P., T. N. Blumer and H. B. Craig. 1960. Quantitative estimations of myoglobin and hemoglobin in beef muscle extracts. J. Animal Sci. 19:1164-1171.

Ginger, I. D., G. D. Wilson and B. S. Schweigert. 1954. Biochemistry of myoglobin. Quantitative determination in beef and pork muscle. J. Agr. and Food Chem. 2:1037-1040.

Hall, J. L. 1954. The spectrophotometer for meat color research. Proc. Seventh Annual Rec. Meat Conf. 7:71-76.

Henry, W. E. and L. J. Bratzler. 1960. Effect of mineral supplementation on pork muscle color as measured by spectrophotometry and disc colorimetry. J. Animal Sci. 19:1195-1203.

Hiner, R. L. 1954. Munsell discs and color paddles as methods of measuring color in meats. Proc. Seventh Annual Rec. Meat Conf. 7:66-70.

Schweigert, B. S. 1954. Quantitative chemical measurement of myoglobin. Proc. Seventh Annual Rec. Meat Conf. 7:77-80.

Wilson, G. 1951. Physical, chemical and organoleptic methods of pork carcass evaluation with special reference to firmness and color. Proc. Fourth Annual Rec. Meat Conf. 4:115-117.

- - - - - - - - - - - -

MR. COLE: That was a very interesting paper by the North Carolina workers and further complicates our work. Apparently we've still got a lot of chores to do in evaluating beef carcasses.

In 1953, as we stated, we had measurements adopted by this Conference, and Mr. Orts is now going to talk to us about carcass measurements.

# # # # # # # # # # # #