The importance of maintaining the acceptability of meat products is appreciated by everyone. One of the major factors in acceptability is the color of the product, both of the lean and of the fat. This discussion will be confined primarily to comments on the determination of myoglobin -- the red pigment of the lean -- in fresh meat.

I would first like to point out that myoglobin is the heme pigment within the muscle and, while it is chemically related to hemoglobin of the blood, it is a different chemical compound. Thus, we feel that it is essential to study chemical reactivity with myoglobin such as the effect of oxygen, etc. I would like to primarily indicate the chemical method we have used for myoglobin and the use of this method in meat research. The objectives in using the method were to determine the total myoglobin content of the muscle or muscle sample from beef or pork cuts, to follow chemical changes in the meat pigment attributable to treatment of the sample, etc. The following method is presented in some detail for beef and pork samples. A few results given with the method indicate some of the applications of the method.

The initial studies were directed toward the quantitative determination of myoglobin in beef and pork muscle. While visual observations of beef and pork muscle indicated that considerable variation in heme pigment content existed, no quantitative data were available. The method adopted for these determinations was taken from Theorell's procedure for isolating myoglobin (1), Morgan's modification of this procedure (2), and Drabkin and Austin's method for the conversion of met-hemoglobin to cyano-met-hemoglobin (3). The method is as follows: The tissue to be analyzed was put through a meat grinder several times to assure homogeneity. It was found that the extraction of myoglobin from such preparations was as complete as when samples were ground in a Waring blender, and the separation of the extract from the protein residue was easier to carry out. Ten grams of the finely ground tissue were mixed with 10 mL of water and allowed to remain overnight in the cold (3-5°C). This extracted the myoglobin, leaving the connective tissue, fat, etc., behind. After centrifugation the supernatant containing the myoglobin was adjusted to pH 7.0. Saturated basic lead acetate equal to 1/4 the volume of the supernatant was then added. The precipitated foreign proteins were removed by centrifugation. The lead acetate was added at room temperature since at lower temperatures the protein precipitation is incomplete and at higher temperatures (38°C) the myoglobin also precipitates (1). Mono- and dibasic potassium phosphate were added to the filtrate from the lead acetate precipitation to bring the phosphate concentration to 3 M and the pH to 6.6. This precipitated the hemoglobin as well as other proteins, and left the myoglobin in solution. The precipitate was removed by filtration through a fine filter paper. An aliquot was then taken, and potassium ferricyanide and sodium cyanide added to provide final concentrations after dilution of 0.6 mM/liter and 0.8 mM/liter, respectively. The potassium ferricyanide oxidizes all the myoglobin to met-myoglobin, and the sodium cyanide reacts with the met-myoglobin to form the cyano derivative. The optical density of the cyano-met-myoglobin solution was then read in the Coleman Junior spectrophotometer at 540 μm. The concentration
of myoglobin in mM/ml. is obtained from the equation, \( E = \frac{O.D.}{C_{cdl}} \), where O.D. = optical density, \( l \) = length in cm. of the path through the solution, \( C \) = concentration in mM/ml, and \( E \) = extinction coefficient of the cyano derivative at 540 mu which was assumed to be 11.5, the same as that of cyano-hemoglobin (4). In calculating the dilution factor, it was ascertained that the distribution of myoglobin between the extract and residue was equal.

Table 1

Myoglobin Content of Beef and Pork Muscle

(All values expressed as mg. myoglobin/gm. of fresh tissue)

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef Muscle</td>
<td>3.70</td>
<td>3.68</td>
<td>3.98</td>
<td>2.79</td>
<td>3.69</td>
<td>4.22</td>
<td>5.41</td>
<td>2.26</td>
</tr>
<tr>
<td>Pork Muscle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light*</td>
<td>0.80</td>
<td>0.66</td>
<td>0.98</td>
<td>0.87</td>
<td>0.84</td>
<td>0.61</td>
<td>0.75</td>
<td>0.82</td>
</tr>
<tr>
<td>Dark*</td>
<td>1.48</td>
<td>1.20</td>
<td>1.44</td>
<td>1.48</td>
<td>1.77</td>
<td>1.04</td>
<td>1.46</td>
<td>1.68</td>
</tr>
</tbody>
</table>

* The light colored muscle was the Biceps femoris, and the darker colored sample was a composite of the Rectus femoris, Vastus lateralis, Vastus intermedius, and Vastus medialis muscles.

With this method the myoglobin content of beef and pork muscle was determined (Table 1). The beef samples were from cuts of rib and round obtained in a local market. The pork samples were obtained from pigs weighing approximately 210 pounds, and both light and dark colored muscles were used in separate determinations. The work with light and dark pork muscle was prompted by observing considerable color variation in different muscles of ham and loin cuts. The samples for analysis were taken from a one inch slice from the center of the hams. A two-fold difference in myoglobin content was observed in different muscles from the same ham (Table 1). These studies were conducted in collaboration with Irene Ginger and Dr. G. D. Wilson, American Meat Institute Foundation, and Dr. W. J. Aunan, Department of Animal Husbandry, University of Minnesota.

In other work being conducted in collaboration with Dr. Lewis and Irene Ginger of our laboratories, we are also attempting to prepare crystalline myoglobin and to follow chemical changes in meat or myoglobin extracts of meat during radiation by gamma rays, etc. For example, Dr. Lewis has shown by electrophoretic analysis that crystalline myoglobin has two components. We are now attempting to prepare sufficient amounts of each component to study the rates of oxygen saturation and other chemical characteristics.

We believe that the application of these techniques as well as the use of reflectance and other types of measurements will be of great value in solving many of the problems of maintaining proper color in both fresh and cured meats.
References


MR. BRAY: Thank you, Barry. I know if time had permitted you could have given us considerable more worthwhile information. Our allotted time has slipped away. So we will have just the briefest of discussion, Al. Dr. Al Pearson will lead the discussion.

DR. PEARSON: Are there any questions?

MR. BRAY: I should like to ask Dr. Schweigert if he has observed any difference in cured two-tone hams that might be influenced by the length of time of cure.

DR. WILDER: That is an extremely difficult thing to evaluate objectively, since we cannot as yet quantitatively determine the quantity of pigment in the cured meat. But dating back to the fresh, we have, of course, seen those differences go back to the animal. There have been some indications that pumping this heavy muscle under the fat cushion will improve the situation. We have not studied this experimentally and when one attempts to determine practices in plants or how they might overcome it, it is very difficult to get objective and realistic information because, of course, there is no specific control of the situation.

In summary I would say that I think some of the two-toned hams that are seen can be improved, but when there is a difference in the pigment concentration to begin with, I don't think we can expect that they will be strictly uniform.

DR. PEARSON: We have time for one more question perhaps, if anyone has a question. If not, I will turn the Chair back to you.

MR. BRAY: I want to take this opportunity to thank the members of the Research Methods Committee for the fine cooperation they gave me in setting up this program.

With that I will turn it back to the General Chairman.

CHAIRMAN WALTERS: Thanks, Bob. Our appreciation to you and to the members of your committee for a very fine and very detailed report on tools for color determination. In view of the fact that we are running a bit late, I believe we had better go ahead with our program. We are planning to pick up the Pork Carcass Evaluation Committee's report begin-
ning at seven o'clock, which means that we will proceed to hear reports from two committees before adjourning for dinner.

The next committee to report is the Research Coordination Committee. This is a new committee, one that was appointed for the purpose of studying possibilities of coordinating research in one area of the United States with another, and specifically possibilities of coordinating research between experiment stations. It was felt by many that there are possibilities for coordinating research in a group of this kind.

We have as chairman of that committee a very able person in Joe Kastelic, of Iowa State College. Joe, we are anxious to hear this first report of the Research Coordination Committee.

MR. KASTELIC: Thank you, Mr. Chairman. I am a little disturbed about the word "coordination," because even the committee is not at the moment coordinated.

I should like to suggest that at this stage of our efforts a more general approach would be more fruitful. Let's not get bogged down in detail. I rather think that the larger problem involves raising questions which relate to area of research endeavor which would be of general interest and amendable to cooperative effort. However, having stated that, how does one attack a problem that one might suggest is suitable for cooperative research effort? This is not, indeed, easy, but I am convinced that cooperative research effort properly developed would assure us a rich harvest of information.

I may, therefore, suggest that the problem before us involves question of the method of attack, the organization of effort, and finding ways and means to bring the information together. Too often we collect the information and we do not do anything with it. But we must know your interests, the facilities that you have, and, perhaps most important, whether you think such cooperative projects are feasible and practical.

Far too many cooperative projects begin with elaborate objectives and all too soon they become unmanageable. If this endeavor is to succeed we must have simple, clear-cut approaches to the problems and we must keep each other informed as to the progress of the particular phase of the research that we may have undertaken to do.

Mr. Butler and Mr. Doty have generously accepted assignments to discuss some of these aspects of the importance of developing and encouraging research on an inter-institutional basis, and since they are covering points that I think will be of considerable interest to you that is all I have to say at the moment.

Thank you.

Mr. Butler.