FACTORS AFFECTING STABILITY OF MEAT PIGMENTS

GEORGE E. BRISSEY
SHIFT & COMPANY, RESEARCH LABORATORIES

There are undoubtedly many motivating factors which affect the homemakers' retail meat purchase. Chiefly among these, however, are her experiences with her particular store and brands. Price too has a way of making itself felt. But, when she is "coming down to the wire" in making her ultimate selection, there is nothing so important as appearance. And of the factors that go into this attribute, none is greater than color.

Today's advanced technical knowledge gives us a measure of control of this aspect. We can therefore capitalize on the tremendous sales potential created by the display appeal of fresh and cured meats through proper development of meat's bright fresh color, the control of this attractive color and the proper display illumination of the meat cuts.

Freshly cut beef has a purple-red color that has little display appeal in the retail case. Good meat market practice allows exposure of the cut meat surface to the air (oxygen) to develop the desired bright red color. This allows the myoglobin to be converted to oxy-myoglobin and is accomplished in a matter of minutes. A similar condition is found in lamb, but is not as pronounced as in beef. In pork and veal an attractive color is present when the meat is cut. The bright color of fresh meat will remain as long as sufficient oxygen is available and no discoloration factors impose dark red, gray, gray-brown, or gray-green colors. Prolonged exposure to oxygen - several hours or days, will bring this about, as will surface drying and bacterial contamination to be subsequently discussed.

Occasionally a dark-cutting beef carcass is found. As the name implies, this beef, when cut, is dull, dark-red or black-red in color and prolonged exposure to air does not brighten its color. The incidence of dark-cutters may increase if animals are subjected to severe changes in handling prior to slaughter. As a matter of fact, the condition may be brought about practically at will through preslaughter treatment. In tests at the University of Missouri, dark-cutters were produced by simulating severe stress conditions through the injection of Adrenalin into the live animal once each day on two days prior to slaughter. As of this date, however, the meat industry does not know how to entirely eliminate dark-cutters. It is important to note that the eating quality of such beef is not impaired.

Occasionally, two-tone meat carcasses occur in beef, lamb or pork. In such meat one muscle may be bright and another muscle from the same carcass may be dark red in color. Of course, there is the normal difference in pigmentation between the so-called working versus non-working muscles. As with dark-cutting beef, there is no solution to this problem at the moment. Of increasing importance to the swine industry is the growing incidence of pale, watery pork. Workers at the University of Wisconsin and others have done much to elucidate the incidence of this condition and to determine the environmental factors which cause it to occur. The condition is manifested in a low, ultimate pH, with some muscles being exceptionally pale to almost
translucent in appearance, a varying two-tone condition with a flabby, exudative surface. Among the immediate factors responsible for its appearance are feeding, activity, temperature and rate of carcass chill. There is evidence that the basic cause, however, resides in genetic factors which have been bred in during the great emphasis on the development of the meat-type hog. This author's experience of 12 to 15 years ago was that the pH of pork muscle tissue would vary in the range of 5.5 to 6.5 with the average being 6.0 to 6.2. In recent time, we have observed a pH as low as 4.8 with the general range running from 5.0 or 5.1 to 6.5 with the average at about 5.6 to 5.8. In one series of studies at Wisconsin, this pale, watery pork was shown to average about 30% at one particular packing plant with an occasional incidence as high as 70% in the case of the heavier (18-20 lb.) weight range of hams.

In order to maintain the desired color of meat, it is necessary to recognize what conditions protect this color, what conditions cause discoloration, and what kind and amount of light provides the best color rendition in the display case. Six general areas affecting the protection and proper illumination of meat will be discussed:

1. Sanitation
2. Temperature
3. Drying
4. Packaging
5. Freezing
6. Lighting

The effects of these factors are usually more pronounced and occur more rapidly on aged meat or meat that has been improperly handled than on freshly dressed or processed meats.

The effect of poor housekeeping leading to poor sanitation is marked. Pronounced surface discoloration can occur in less than one hour if the meat surface is brushed with a heavy bacterial inoculation. Such a condition can happen with direct contact with an aged piece of meat, uncleansed blocks or cutting boards, and dirty equipment. Any practice which increases the surface bacterial load on meat cuts will promote surface discoloration. In this connection, however, it is interesting to note the inhibiting effect of phosphate curing in delaying the onset of greenish bacterial discoloration in ham. Paired hams were cured with and without phosphate, processed, aseptically sampled, ground, placed in sterile petri dishes, and sterilized with ethylene oxide gas. The samples were then inoculated with cultures of known "greening" organisms and incubated at 100°F. The non-phosphated ham turned green in less than four hours while its paired phosphated mate remained normal in appearance for at least double that time.

Poor colors of cut meat surfaces are directly correlated with surface meat spoilage. It is therefore natural and expected that the rate of discoloration of meat cuts in the display case is increased with increased storage temperature. Meat cuts displayed at 38-42°F will, in general, discolor in one day, while cuts displayed at 32-34°F may maintain excellent color for periods of up to three or four days. In general, the normal spoilage bacteria on cut meat surfaces, at these relative temperatures, will multiply ten times more rapidly with each five degree increase in temperature.
Improper sanitation and poor temperatures can combine to bring on discolo-
ration and spoilage within a matter of a few hours.

An unattractive brick red color results as cut meat surfaces lose
surface moisture and dry. Low humidities, excessive air movement and non-
moistureproof packaging material promote surface drying. Surface drying
does not entirely inhibit surface bacterial growth. Thus, protection
against drying may set up a moist surface condition that requires optimum
sanitation measures and temperatures if more than one day's display case
life is desired.

Since packaging materials are available which will give any degree
of oxygen and moisture permeability, it is possible to maintain good color
with proper packaging materials or to promote discoloration through the use
of improper packaging materials or materials improperly applied. It is well
known that fresh meat packaging films will maintain the bloom of the meat
for several days if proper care is taken to guard against other discolora-
tion factors.

When a non-moistureproof film is used, a dried surface and hard
brick red color develops in a very short time.

With fresh meat the use of a vacuum package and an oxygen imper-
meable film will always produce a dull purple-red color. It is generally
accepted that this dull purple-red color does not have the appeal of the
bright red color maintained with proper fresh meat packaging film. However,
a vacuum package does provide a longer display case life. This results,
because of the fact that the vacuum package, and the oxygen impermeable
film provide a nearly oxygen free package which is not conducive to the
growth of the normal spoilage bacteria found on meat. There is a growing
utilization of vacuum packages on fresh ground meat. The consumer has
found that when the meat is removed from the package, the characteristic
bright red color is quickly formed.

Freezing and storage temperatures of frozen meat have a marked
influence on color. A quickly frozen cut of meat has a bright red color.
A slowly frozen cut is dark red in color. Quick freezing produces small ice
crystals and when the meat is thawed the drip loss is less than in the
slowly frozen cut where larger ice crystals have been formed in the meat.

Frozen meat when stored at relatively high temperatures - 10°F to
25°F., will discolor even though it was originally quick frozen and did
originally have a bright red color. The rate of discoloration can be very
rapid, a matter of just a few weeks at temperatures around 25°F. Much of
the discoloration of fresh frozen meats in freezer display cases is due to
the fact that the frozen meat cuts are not held at temperatures of 0°F or
lower.

The position of the meat cuts in the case can affect the color of
the packaged meat item. Very often the package is placed too high in the
case and does not have the advantage of the proper freezer temperature. In
addition, the fluctuation of temperatures due to defrost cycles and surface
warming due to radiant heat from high intensity light contribute to more
rapid discoloration in the display case than is found in a closed freezer.
Everyone has noted the frost that accumulates in a package when the packaging film is not in close contact with the meat surface. Wherever such frost appears and whenever a non-moisture-proof packaging film is used, freezer burn will develop. Freezer burn detracts from the appearance of the meat and if it continues to develop under prolonged storage, will cause a decrease in the juiciness of the meat and may lead to undesirable flavor of the meat when cooked.

The effect of good and poor illumination is most startling. The intensity of light itself is most important. Case and store lighting has been constantly increased. Stores today have as much as 200 foot candles of light, sometimes over 100 foot candles of light at the level of the meats in the display case. Meat displays that had 30 foot candles of light at the product now have 60-80 foot candles or more. The brilliance of the display is greatly enhanced by increased light intensity.

There is some question concerning possible undesirable effects of high intensity light levels. It may be that radiant heat from such intense light actually causes an increased temperature on the surface of the meat. Such an increase in temperature could, of course, promote the rate of bacterial growth and as a result promote discoloration. Incandescent lighting has been developed using special fixtures to provide high level light intensity without excessive heat and is or soon will be commercially available. In addition, if there is any ultraviolet radiation at the high intensity light levels, discoloration will be increased because ultraviolet light will discolor fresh meat cuts. Under relatively normal lighting intensities of 50 foot candles or under fresh meat does not discolor in a matter of one or two days display case life.

Whether to use incandescent lights, fluorescent lighting, or a combination of these two is a matter of opinion. Everyone likes the color rendition secured with incandescent lighting. Many believe that proper fluorescent tubing produces an excellent display effect. Improper fluorescent tubing, however, can produce a very unsatisfactory display.

Color enrichment possible with special colored lights is a very questionable practice. As long as the meat remains under these lights the appearance is outstanding. If the shopper notices the meat package after she leaves the display and finds the color undesirable, she may drop the package most any place in the store.

Discoloration is the most important problem connected with the marketing of cured, smoked, and Table-Ready Meats. This does not mean that the factors of sanitation, temperature, drying, packaging, freezing, and lighting which were discussed in the relationship to fresh meats should not be given equal consideration in the handling of cured, smoked, and Table-Ready Meats. In general, however, any cured meat item will discolor as the result of display under lights before any of the above mentioned factors become effective. Discoloration in these processed meat items occurs when the cured meat pigment in the processed product combines with the oxygen of the air to produce brown, grey brown and grey green discolorations. Vacuum packaging, of course, admirably takes care of this. As opposed to fresh meats, the cured meats retain their desired pinkish-red color in the absence of oxygen. This chemical reaction of the cured meat pigment and oxygen is accelerated when the product
is displayed under light and the rate of change or reaction is correlated with the intensity of the light. Intense light can stimulate this oxidative process so that the bloom of freshly sliced product can be lost within a period of one hour or even less. On the other hand if the intensity of the light is maintained at under 30 foot candles, bright color can be retained for at least one-half day in non-vacuum packaged product. Fluorescent lights do not discolor cured meats more rapidly than incandescent lighting. As long as the light intensity is the same the meat discoloration problem will be just as severe regardless of the source of light.

In a previous discussion characteristics and properties of meat pigments were presented. In the present paper an attempt was made to show the practical implications of these characteristics and properties by discussing the effects of common, simple factors such as oxygen, temperature, bacteria and light on the stability and appearance of meat pigments.

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MR. SAFFLE: Thank you very much, George.

We have ample time for a discussion, if anybody has a question they would like to ask either one of the previous three speakers?

George, I'd like to ask one myself -- In the last year or two we have seen a great deal more emphasis put onto vacuum packaging, particularly of ground meat, and using something where we do not see through the film. From an industrial standpoint do you think this will become more important and a major way of selling ground meat or not?

MR. BRISSEY: Yes, I think this movement is definitely in this direction to pre-package ground meats at the packer level for distribution to the retail trade. The fact that the pigment changes so rapidly upon exposure to oxygen or to the air so that the homemaker, if she does see through the package and sees the brown surface on the package, the minute she cuts it she gets the desired bright red color.

MR. SAFFLE: I might mention one thing of interest, we have one chain store in Georgia who came out with what they call a prestige steak, and it is a high-quality steak cut extra thick, and they wrap it in a vacuum package and it has the purple color of myoglobin, and actually they use this as a sales point and, if anything, it has gone over better than if it had the red color. As you go down the showcase you immediately see this purple color and it stops you for a moment and you end up reading their little advertisement above it, and they do put out a top-notch product and in this particular case they have taken something which we said they couldn't do and made it into a selling point.

Are there any other questions anybody might like to ask?
MR. VERN CAHILL (Ohio State): Is there any evidence that a product which has been vacuum packaged will have a shorter shelf life than one that is open?

MR. BRISSEY: The question is, is there any evidence to indicate that a vacuum-packaged product will have a shorter shelf life than one that is open?

I can't think of anything with respect to freshness, however, because of the metabolic processes going on in the vacuum package if you have had some of these peroxides that Dr. Fox mentioned in curing these items which have been vacuum-packaged. I have seen these cured meats turn green within ten minutes after opening the vacuum package when they were a perfectly bright red color as long as the vacuum package was present, and the discoloration would take place very, very rapidly once it is removed.

MR. SAFFLE: Are there any other questions?

If not, Jim, we will put you back on time schedule, and even gained some, which I guess is unusual.

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CHAIRMAN KEMP: Thank you, Bob.

At this time we will have the report of the Membership Committee, and George Wellington, we will turn the program over to you.

MR. GEORGE WELLINGTON (Cornell): Thank you, Jim.

My report is very brief, and I think it will consist for the most part in passing out the Directories. Many of you have received a copy of the Directory which has been available for the past few days; I know there are many here who did not receive it so I will just pause a minute while it is passed out.

The Membership Committee consists of Adams, Bratzler, Bray, Cahill and myself, and as Chairman Kemp assigned the Committee he gave us these responsibilities: First, to publish the Directory, and this we tried to do knowing that there would be some incompletions. We did the best we could with it. We know that there are some errors in it, and we are sorry where it is incomplete. We have tried to make it accurate to the extent that it agree with the yellow sheet which has been submitted. I hope that it is correct to that extent.

I think you will probably be interested in knowing that we took bids on the cost to print 1,000 copies. We had bids ranging from about $900.00 up to about $1,450.00. Actually we gave the job to the lowest bidder. Due to the selection of the cover material there was a little more cost to the printer than we had anticipated. The final bill was about $950.00, so these copies cost about $.95 each. I think when and if it is done again we probably could do a better job by getting more complete...