Meat Technology

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CONTENT

MEAT QUALITY

- WATER HOLDING CAPACITY OF MEAT
- COLOR OF MEAT
- TENDERNESS AND TEXTURE
- FLAVOR AND TASTE

Water holding capacity (WHC) of meat

- WHC is defined as the ability of meat to hold its native and added moisture during fabrication and through processing.
- Because 75% of the weight of lean skeletal muscle is water, retaining and controlling the location of this inherent or added water is critical to maximizing yield and quality.

Higher WHC usually is accompanied by:

- **Firmer meat**
- **Less pale lean color**
- **Less purge in packages**
- **Less drip loss**
- **More brine & marinade retention**
- **Better processing and cooking yields**
- **More juiciness and tenderness**
- **Better protein functionality**
- **Fewer consumer complaints**
- **More competitive advantage**

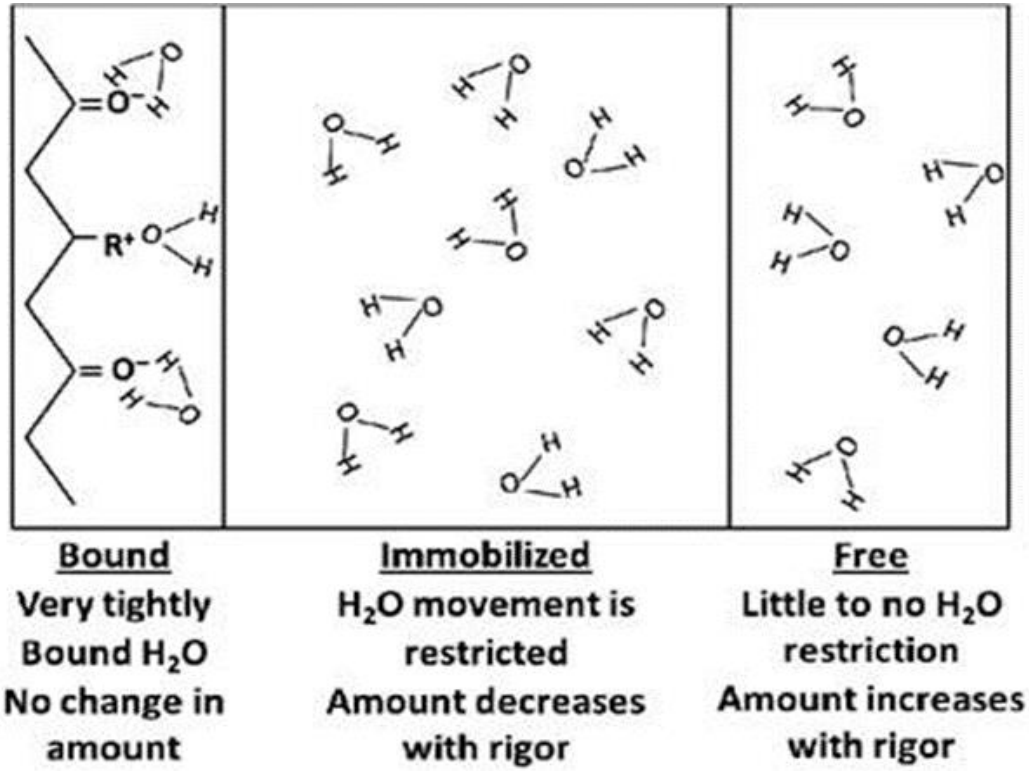
Water holding capacity (WHC) of meat

There are three compartments (forms) of water bound in meat, namely;

Bound water-

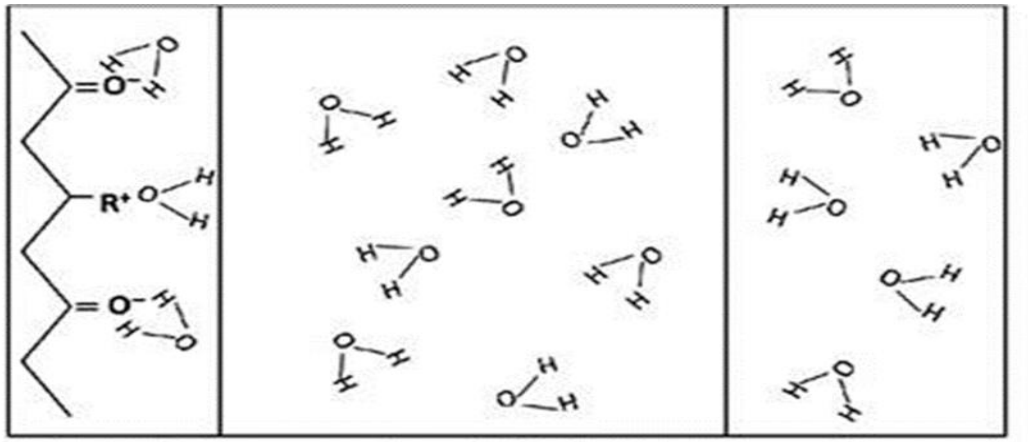
Immobilize water-

Free water



Water holding capacity (WHC) of meat

Bound Water: This compartment of water is the smallest (1-2%) and the strongest of the three.



Water holding capacity (WHC) of meat

Immobilized Water:

Up to 80% of the water in fresh meat is immobilized.

Water in this compartment ranges from moderate electronic associations between water and the muscle proteins to very weak associations as the water molecules increase in distance from the positive and negative charges on the proteins.

Water holding capacity (WHC) of meat

Free Water:

- Water in this category is subject to being lost.

- The major restrictions for this water are the cell membranes and capillary restrictions related to the width of the spaces between the interfibrillar strands of muscle proteins.
- Any combination of forces that damage muscle cellular integrity will help release free water from meat.
- During the conversion of muscle to meat, the changes in water holding capacity of meat depend upon the rate and extent of the pH decline and the extent of protein denaturation.

Major factors affecting WHC of meat

-Animal genetics

-Pre-harvest handling

-Conversion of muscle to meat

Meat color

Two main pigment in meat:

Myoglobin

Hemoglobin

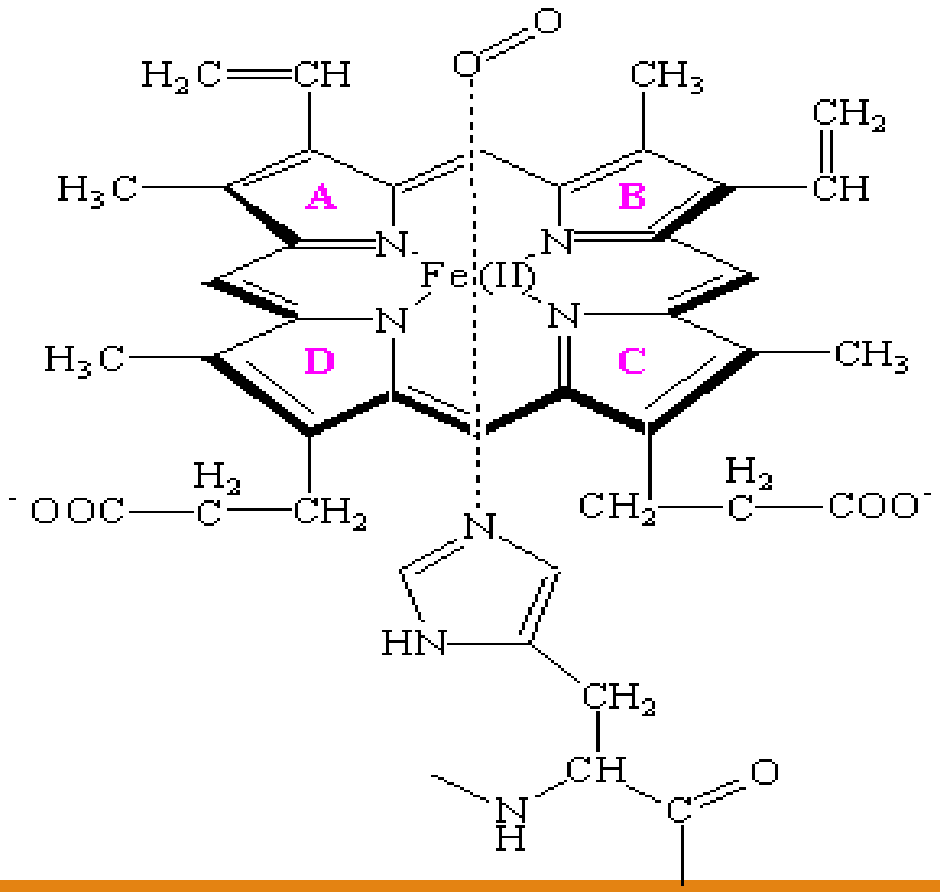
Majority of meat color is due to myoglobin

Meat color

Depend on

- Pigment content
- Ultimate pH and rate of pH decline durin postmortem period
- Nature of group attached to the iron and state of the iron
- Ingredients, processing, packaging

Meat color
Myoglobin



Mygoglobin

What is the function of myoglobin?

It is the protein that stores oxygen for active muscles.

Function as a reservoir of oxygen and as an oxygen carrier.

It is found in the sarcoplasm.

It increases the rate of transport of oxygen within the muscle cell.

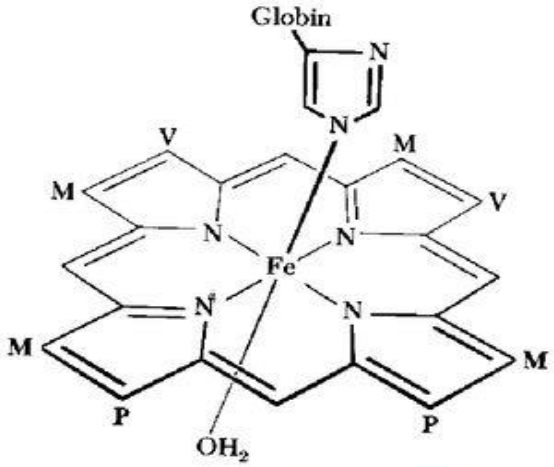
Myoglobin (Mb) forms

- Deoxymyoglobin (DMb)
  - Mb in its native state
  - Appears purple
  - Ferrous (Fe^{2+})
  - Seen uncut meat and vacuum packed meat
- Oxymyoglobin (OMb)
  - Mb has been oxygenated (bloomed)
  - Appears red
  - Ferrous (Fe^{2+})
- Metmyoglobin (MMb)
  - Myoglobin has been oxidized
  - Appears brown
  - Ferric (Fe^{3+})

Myoglobin forms

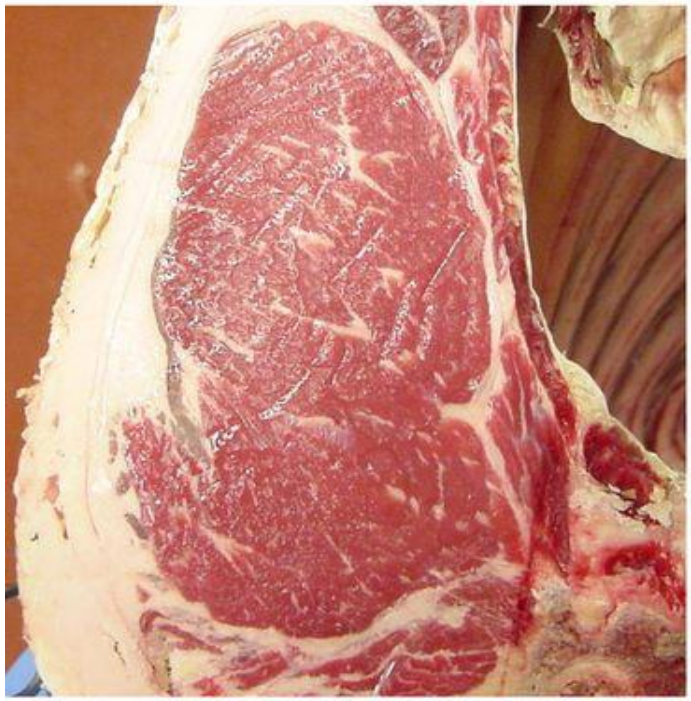
- Carboxymyoglobin (COMb)
  - Mb has been exposed to CO
  - CO binds to Fe more strongly than O_2
    - Greater binding affinity by Mb
  - Appears red
  - Ferrous (Fe^{2+})
  - Very similar to OMb

Deoxymyoglobin



- Occurs when no ligand present for binding 6th site
- Heme Fe is Ferrous (Fe++)
  - Uncut Meat
    - *Only water present to bind*
- Very low oxygen tension required
  - Typically associated with Vacuum Packaging
    - *Consumer acceptance of vacuum packaged products?*
- Purplish-red or purplish-pink color

Oxymyoglobin



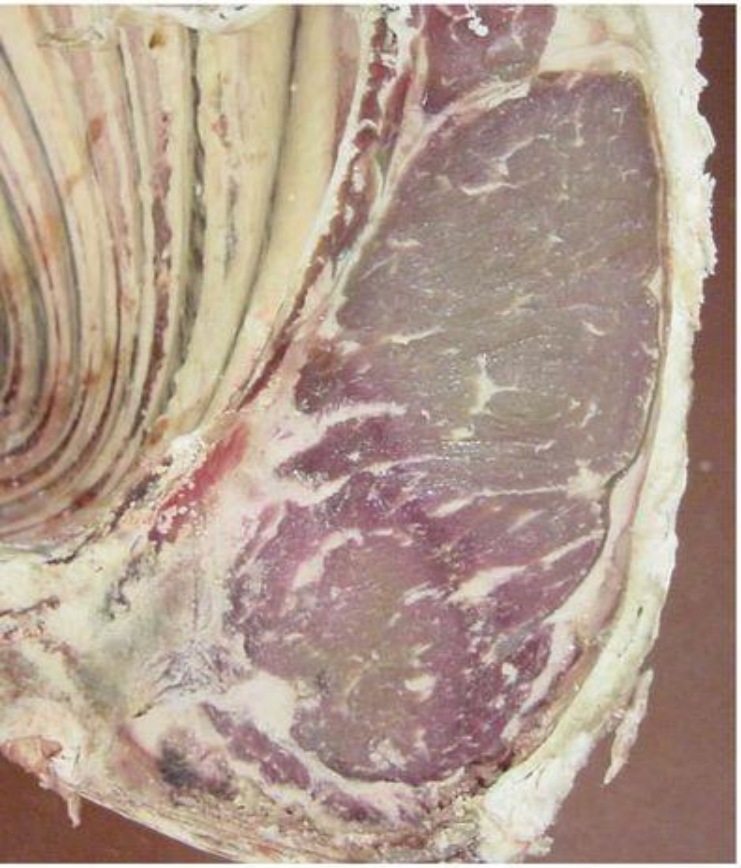
- Heme Fe is Ferrous (Fe++)
- Cut meat exposed to O_2
  - *No change in iron's valence*
- *6^{th} binding site occupied by diatomic oxygen*

- Distal histidine interacts with bound O_2
  - *Requires 40 torr partial pressure of O_2 (5.25%)*
- *Alters structure and stability*

- Bright Cherry Red color
- As exposure increases-OMb penetrates deeper
  - *High O_2 maintains OMb, but may induce Oxidation reactions*

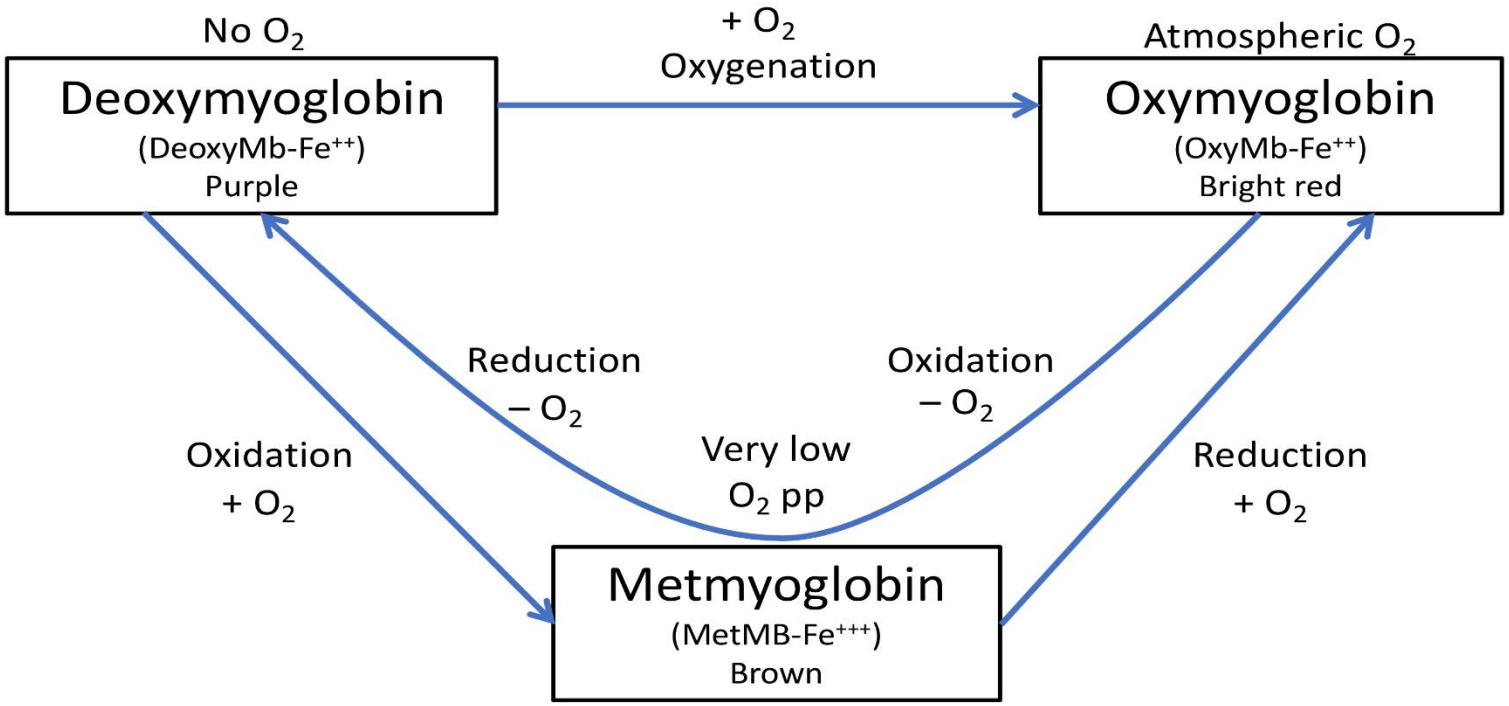
- Unstable formation
- *Electron availability*
  - *Stability depends on continuing supply of O_2 Oxidative Metabolism enzymes rapidly use O_2*

Metmyoglobin



- Oxymyoglobin is very unstable
- Oxidation of ferrous (Fe^{2+}) Mb to ferric (Fe^{3+})
- Reasons for Formation of MMb: *O_2 levels of 0.2-1.3%*
  - *Complete Oxygen Consumption*
    - *Cellular respiration*
- *Low partial pressures of O_2 (5-10mm/ 2.6-5.3%)*
- *Low MMb reducing rates*
- *Low Oxygen transmission rates*
  - *Surface contamination*
    - *Aerobic bacteria use up O_2*
- Brown Color
- Surface Discoloration *MMb located between superficial OMb and interior DMb*
  - *gradually thickens and moves to surface*

Chemical state of myoglobin



Sources: Inspired by Kropf (2003), Proc. 56th Recip. Meat Conf., 73-75 and Mancini and Hunt (2005), Meat Sci. 71: 100-121.

Chemical state of myoglobin -- Ferrous or Fe^{++} (covalent bonds)

Compound	Color	Name
H_2O	Purple	Deoxymyoglobin
O2	Bright red	Oxymyoglobin
H_2O	Red	Myoglobin
NO	Cured pink	Nitric oxide myoglobin
CO	Red	Carboxymyoglobin

Chemical state of myoglobin -- Ferric or Fe^{+++} (ionic bonds)

Compound	Color	Name
-CN	Red	Cyanmetmyoglobin
-OH	Brown	Metmyoglobin
-SH	Green	Sulfmyoglobin
$-H_2O_2$	Green	Choleglobin

Factors affecting meat color

Meat color is impacted by the following factors:

- Species
- Breeds
- Feeding
- Age, sex
- Muscle activity
- pH
- Oxygen

Different meat colors are caused by

- Different concentrations of myoglobin,
- Chemical state of myoglobin (Mb, OMb, MMb)

Myoglobin differences: Age within species

Age class	**Myoglobin content**
Veal	2 mg/g
Calf	4 mg/g
Young beef	8 mg/g
Old beef	18 mg/g

Myoglobin differences: Species effects

Species	Color	Myoglobin content
Pork	Pink	2 mg/g
Lamb	Light red	6 mg/g
Beef	Cherry red	8 mg/g

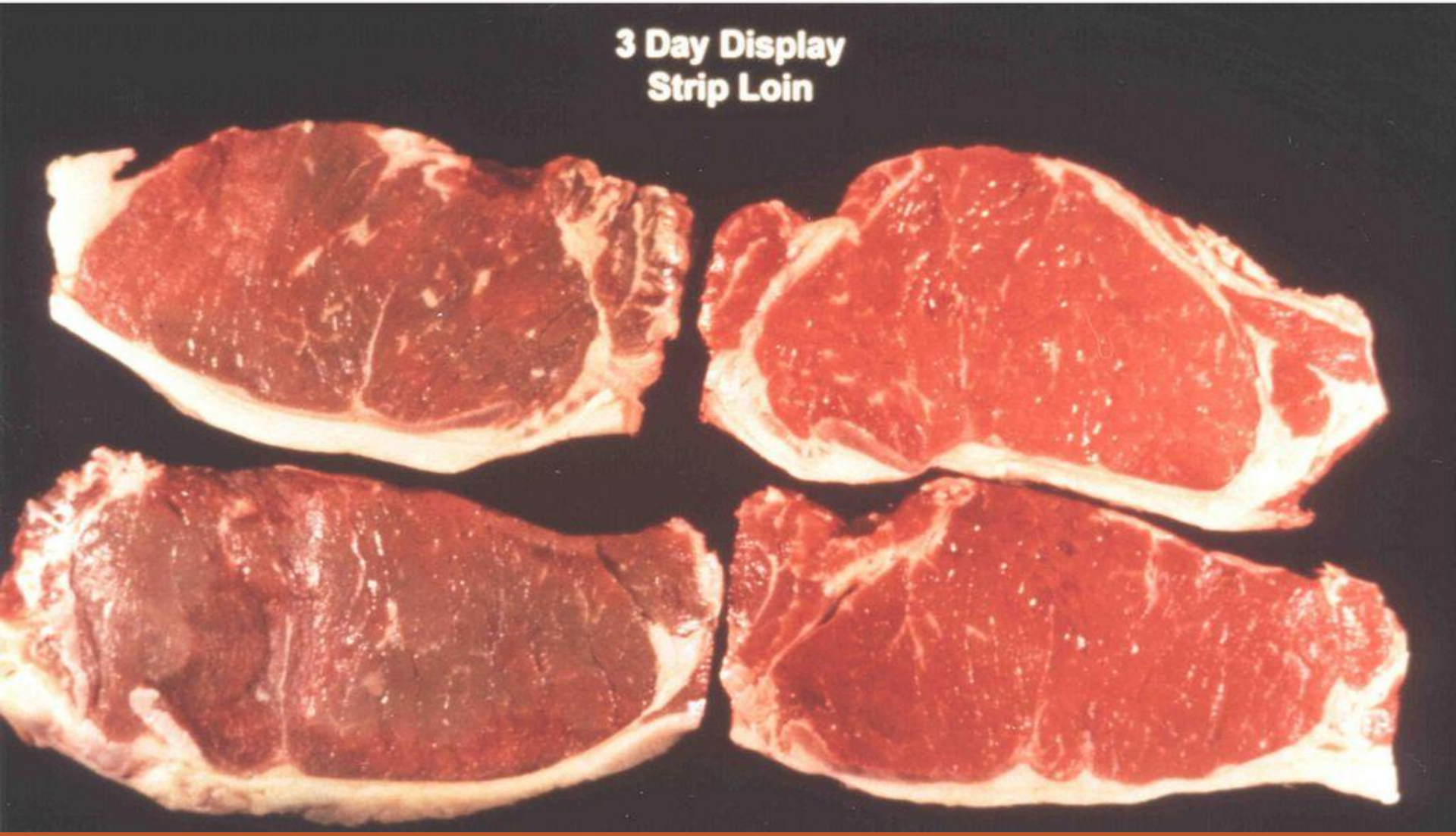
Myoglobin differences: Muscle effects

Muscle type	Name	Myoglobin content
Locomotive	*M. extensor carpi radialis*	12 mg/g
Support	*M. longissimus thoracis et lumborum*	6 mg/g

Factors Affecting Meat Color

- Vitamin E feeding of cattle
  - Prevents oxidation; retards conversion of myoglobin to metmyoglobin
- Bacteria
  - Produce metmyoglobin, choleglobin, and sulfmyoglobin pigments
- Curing
  - Nitrosylhemochromogen is the stable cured meat pigment

Vitamin E

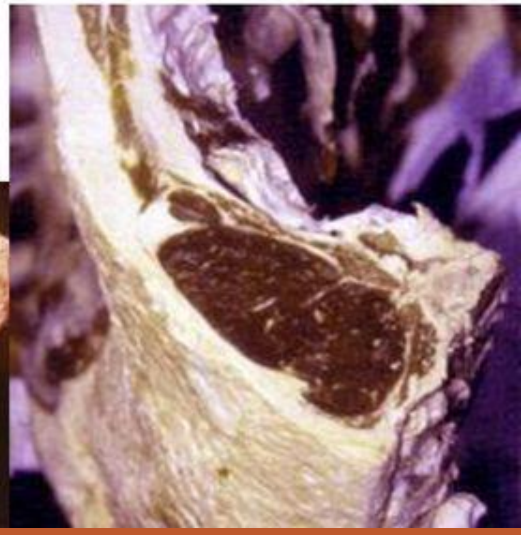


Factors Affecting Meat Color

Pre-Harvest Stress

Exposure to long-term or short term stress

- Effects glycogen content of muscle and ultimate pH of muscle
- Long Term Stress: DFD (dark cutter)*Transport, Hunger, Fear, Aggression*
- *Ultimate pH above 5.9 (beef), 6.5 (pork)*
- Short Term Stress: PSE *Usually only problematic in pork*
  - *Ultimate pH below 5.4*
    - *Generally problem can be overcome with enhancement*

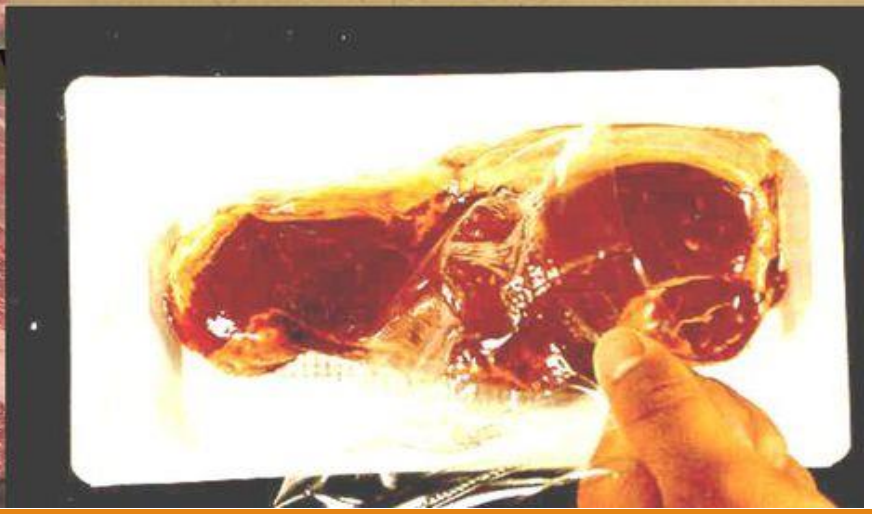


BEEF:

Example of how meat colour is affected by ultimate pH

Factors Affecting Meat Color

- Packaging



Curing

the addition of salt, sugar and nitrite or nitrate for the purposes of preservation, flavor and color

Myoglobin

Oxymyoglobin plus NO→ nitric oxide myoglobin plus heat → Nitrosyl hemochromogen

Metmyoglobin

Tenderness and texture

- Myofibril structure and contraction status.
- The composition of connective tissues and the level of its cross-ties.
- Water holding capacity by meat protein and meat juice.
- The texture of meat is the size of muscle bundles surrounded by perimysium of connective tissues dividing muscle longitudinally.

Tenderness and texture

- Tenderness is affected by connective tissues in meat (epimysium, perimysium and endomysium).

- The older the animal, the lower the tenderness because of denser and thus stronger connective tissues.

- The types of muscle also influence the level of meat tenderness due to different physiological functions of muscle.

Flavor **and taste**

- After appearance and tenderness flavor is most important.

Factors affecting meat flavor are:

- feeding,
- age,
- species,
- breeds,
- sex,
- fats,
- duration and condition of storage after slaughter,
- cooking method, duration, and temperature.

Factors affecting meat flavor

Fat

- Amount and type

Muscle

- Location effect

Aging

- Dry vs. wet

Enhancement

- Brine solution containing salt

Cooking method

- Dry vs. moist heat
- Degree of doneness

Taste versus flavor

Taste refers to the five basic receptors: sweet, salty, sour, bitter and umami

Flavor is the perception of chemical compounds reacting with receptors in the oral and nasal cavities (aroma) in combination with taste.

Flavor chemistry

Over 200 flavor compounds associated with cooked beef:

- Sulferous and carbonyl compounds are predominate contributors
- Maillard reaction products
  - End product results from sugars and amino acids
- Lipid breakdown products
  - Higher concentrations may produce undesirable flavors