An Update on Packaging Fresh Meat with Nitrite Containing Film

Kansas State University
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Curwood, div. of Bemis Corporation is Marketing under the trademark:

FreshCase®
The Retail Grocer’s Fresh Meat Package (1960-present)

Display Life:
Pork, Beef, Lamb = 3 days
Chicken = 5 days

Typical Wrapped Tray
PVC stretch film (oxygen permeable), soaker pad and Expanded Polystyrene tray
Case Ready Packaging

“Typical Wrapped Tray”
Poor for Case Ready Red Meat

- Red meat color turns brown within 3 days
- At least two weeks are needed to allow for distribution from a centralized facility.
The Case Ready Chicken Package

Typical Wrapped Tray

Printed polyolefin shrink wrap (oxygen permeable), soaker pad and expanded polystyrene tray

Shelf Life = 10 - 14 days
Case Ready Market Today (2010)

Percent of market by category:
1. Chicken – 94%
2. Pork - 58%
3. Ground Beef – 71%
4. Whole Muscle Beef - 31%
Fresh Meat Color Triangle

- **Fresh Cut Deoxymyoglobin Mb (Fe²⁺)**
- **Discolored Metmyoglobin MetMb (Fe³⁺)**
- **Bloomed Oxymyoglobin MbO₂ (Fe²⁺)**

Directions:
- Oxygenation
- Reduction
- Oxidation
The Effect of Time on Surface Pigments

**Metcurve**

Typical PVC Wrapped Tray

The Effect of Time on Surface Pigments

<table>
<thead>
<tr>
<th>Time (days)</th>
<th>Relative Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100 %</td>
</tr>
<tr>
<td>5</td>
<td>0 %</td>
</tr>
<tr>
<td>10</td>
<td>40 %</td>
</tr>
<tr>
<td>15</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Graph showing the percentage change over time for different pigments:
- OXY
- MET
- DEOXY
Extend color life of red meats:

- **Additives** e.g. phosphates, sequestrants, reducing agents and antioxidants.
- **Packaging** e.g. peelable barrier, perforated venting, active gas exchange.
- **Gases** e.g. pressurized gases, noble gases, elevated oxygen and carbon monoxide.
Case Ready Packaging Formats

1. High Oxygen MAP tray
2. Oxygen free MAP with CO
   a. Individual Tray
   b. Motherbag
3. Nitrite Film Packaging
1. High Oxygen MAP

Oxygen as a Myoglobin Blooming Agent

Shelf Life $= 10 - 14$ days
Fresh Meat Surface Color
High Oxygen MAP

Oxygenation

Fresh Cut
DEOXY
Mb (Fe$^{2+}$)

Oxidation

Bloomed
OXY
MbO$_2$ (Fe$^{2+}$)

Reduction

Discolored
MET
MetMb (Fe$^{3+}$)

O$_2$ used as myoglobin blooming agent

Oxygenation
Metcurve
High Oxygen MAP

The Effect of Time on Surface Pigments

The graph shows the relative percentage of OXY, MET, and DEOXY over time (days) from 0 to 15. OXY decreases over time, MET increases, and DEOXY remains constant. The graph illustrates the effect of time on surface pigments.
Premature Browning

Chub

High Ox MAP

Cooked to 140°F Internal

Oxidation by High Ox MAP
Black Bone

Oxidation by High Ox MAP
Disadvantages of High Oxygen MAP

- Oxidation of color/flavor
- Premature Browning
- Black bone
- Shelf life (< 2 weeks)
- Display life (< 3 days)
- Bulky (higher costs for shipping, warehousing, and display)
- Poorly suited to freezing
- Off-line leaker detection
- Sustainability and cost
2. Oxygen free MAP with CO
   a. Individual Tray

   CO as Myoglobin Blooming Agent
   Shelf Life > 28 days
2. Oxygen free MAP with CO
b. Mother Bag
Markoglobin Carboxylation:

1. Reducing Ability
2. Carbon Monoxide

CO is used as myoglobin blooming agent

Fresh Meat Surface Color
Oxygen Free MAP with CO

Fresh Cut
DEOXY
Mb (Fe \(^{2+}\))

Bloomed
CARBOXY
MbCO (Fe \(^{2+}\))

Discolored
MET
MetMb (Fe \(^{3+}\))

Carboxylation by CO

Oxidation

Reduction

e

Myoglobin Carboxylation:
1. Reducing Ability
2. Carbon Monoxide
The Effect of Time on Surface Pigments

Oxy

Met

Carboxy

Deoxy
Disadvantages of CO MAP

- Bulky (higher costs for shipping, warehousing and display)
- Poorly suited to freezing
- Off line leaker detection
- Sustainability and cost
- Consumer concern
PVC Wrapped Tray in Mother Bag

Additional disadvantages:
- Short display life (3 days)
- Leaking packages
- Sustainability and cost
Causes a stable consumer preferred red color in a vacuum package by nitrosylating the myoglobin pigments that comprise the viewing surface.
Resin Pellets
Basic Cast Extrusion

Nitrite Containing Resin

Barrel

Screw

Extrusion Die

Film
Cross Section of Nitrite Film

- Package Exterior
- Outer Layer
- Sealant Layer
- Barrier Layer
- Meat Product Surface
- Invisible Sodium Nitrite Crystals
3. Nitrite Film Packaging

Amount of Nitrite:

- Less than 113 mg/m²
- Typical ingoing nitrite for beef < 2 ppm.
- Residual nitrite is not detectable.
3. Nitrite Film Packaging

- The **optimum** amount of nitrite is directly related to the concentration of myoglobin in the meat.

  - Beef: 3-10 mg/g
  - Pork: 1-3 mg/g
  - Poultry: <1 mg/g
Myoglobin Nitrosylation:
1. Nitrite containing film
2. Fresh Meat
3. Vacuum Packaging
4. Bloom time

Fresh Cut
DEOXY
Mb (Fe^{2+})

Bloomed
NITROXY
MbNO (Fe^{2+})

Reduction

Discolored
NITROXY
MbNO (Fe^{2+})

Fresh Meat

Nitrosylation

NO is used as a myoglobin blooming agent

Oxidation

Discolored
MET
MetMb (Fe^{3+})

Bloomed
OXY
MbO2 (Fe^{2+})

Reduction
Metcurve
Nitrite Film Packaging

The Effect of Time on Surface Pigments
Curing vs Nitrite Film Packaging

Curing (150-200 ppm NaNO₂):
- Fresh Cut: Deoxy (Fe²⁺)
- Discolored: NitrosoMet (Fe³⁺)
- pH < 5.0
- NO from NaN0₂
- Heat
- Dinitrosohemachromagen (Fe²⁺)
- Salt, nitrite, erythorbate

Nitrite Film Packaging (1-10 ppm NaNO₂):
- Fresh Cut: Oxy (Fe²⁺)
- Discolored: NitrosoMet (Fe³⁺)
- Nitrite
- Nitroxy (Fe²⁺)
3. Nitrite Film Packaging

Requirements:

1. The Film
   - Barrier to oxygen
   - Source of Nitrite

2. The Meat
   - Fresh Meat with good reducing activity (MRA/ARA/OCR)

3. Vacuum Packaging
   - Eliminates atmospheric oxygen
   - Causes the film to make intimate contact with meat surface
   - Must be hermetically sealed to prevent ingress of oxygen

4. Refrigerated Storage (12-60 hours)
   - Migration of Nitrite and reactions that cause nitrosylation
3. Nitrite Film Packaging

Suitable Packaging Formats:

- Vacuum skin pack
- Forming/nonforming
- Chub casings
Vacuum Skin Pack - Beef
Vacuum Skin Pack - Pork

Pork Chops after 30 days
Forming/Nonforming – Beef Flat Iron

Forming: Clear w/ Nitrite
Nonforming: Black w/o Nitrite

Note: soaker pad is optional for enhanced cuts
Chub Casings

Ground Beef

Nitrite Film

Control Film
Label Example

New York Strip Beef Steak

Vacuum Packaged with Nitrite Containing Film to Protect Flavor and Color

USE OR FREEZE BY
Aug 1, 2011

1.5 lb. $8.99

TOTAL PRICE $13.48

KEEP REFRIGERATED
Advantages/Benefits

- Oxidation of color/flavor
- Premature Browning
- Black bone
- Shelf life (< 2 weeks)
- Display life (< 3 days)
- Bulky (higher costs for shipping, warehousing, and display)
- Poorly suited to freezing
- Off-line leaker detection
- Sustainability and cost
Comparison of Sustainability and Cost

CO Motherbag vs FreshCase®
Sustainability Comparison

CO Motherbag vs Vacuum Package

- 60% less packaging by weight
- 40% less fuel for freight
- 10-15% reduction of meat (and its packaging) in landfills
Cost to the Consumer

CO Motherbag vs Vacuum Package

1. Processor Savings = $0.44/lb
   • Packaging and freight
2. Retailer Savings = 10-15%
   • Losses, shrink and mark downs

Total Reduction of Retail Pricing: $1.00 – $1.50/lb
Recent Developments in FreshCase®

July, 2010: FreshCase® received GRAS status for fresh beef

Jan, 2011: First patent awarded by USPTO

Jan, 2011: Curwood launches sales and marketing effort to commercialize FreshCase® films for fresh beef

May, 2011: FreshCase® received GRAS status for other species e.g. chicken, pork, veal and lamb
Fresh Meat Research Opportunities

- Bloom time and intensity
- Nitrite loading and fate of nitrite
- Factors affecting metabolism (MRA, OCR and mitochondria)
  - Animal Variations (Genetics, Diet, Age, Sex, Breed, Species, Individual muscle and postmortem age)
  - Beta agonists e.g. zilpterol or ractopamine
  - Slaughter conditions
  - Enhancements/Antimicrobial sprays
  - AMR
- Consumer attitudes/acceptance
Packaging Fresh Meat with Nitrite Containing Film

For more information go to:
www.curwood.com/products/554/#freshcase

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