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Fundamentals of Modified Atmosphere Packaging of Retail Ready Beef

C.O. Gill

Lacombe Research Centre

Canada

Commercial Reasons for Implementing MAP

- Facilitate central cutting
- Extend display life
- Enhance appearance

Technical Requirements

- Preserve organoleptic qualities of freshly cut meat, particularly color.
- Delay microbial spoilage.
- Minimize costs for packaging and refrigerated space.

Modified Atmosphere Pack Types

- Retail packs
- Master packs
- High oxygen atmosphere
- Low oxygen atmosphere
- Zero oxygen atmosphere

Gases in MAP Atmospheres

Oxygen

Carbon dioxide

Nitrogen

None

Carbon monoxide

Argon

Oxygen

High concentrations:

- Enhance meat colour

- Delay discolouration

- Accelerate rancidity

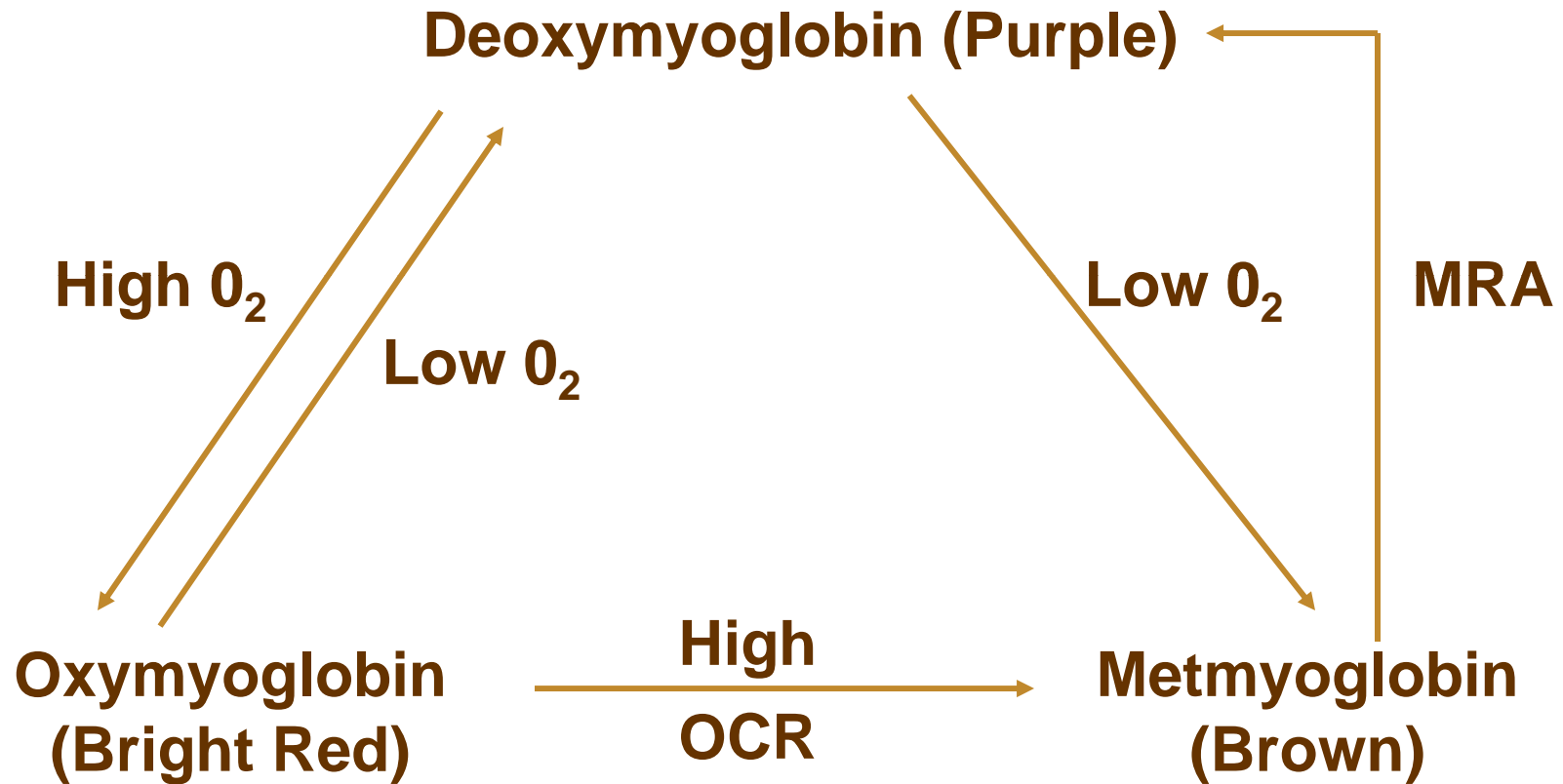
- Toughen meat

Low concentrations:

- Accelerate discolouration

- Permit growth of aerobic spoilage bacteria

Muscle Myoglobin and Oxygen



Colour Stabilities of Muscle and Marrow Exposed to Oxygen

- Intrinsic colour stabilities of muscles can differ by a factor of three.
- Colour stabilities of all muscles will be similarly low after storage of meat in vacuum pack.
- Colour stability of bone marrow will be low after storage in vacuum pack.
- Colour stability will decline linearly with temperature, by between two and five fold with a temperature increase of 10°C.
- Colour deterioration will usually determine the storage and display life of meat.

Rancidity and Toughening of Meat Exposed to Oxygen

- Rancidity develops more rapidly with unsaturated than with saturated fat.
- Rancidity develops more rapidly in colour unstable than in colour stable muscles.
- Oxidation and cross linking of muscle proteins can lead to toughening of meat.

Aerobic Spoilage Flora

- Spoilage flora in atmospheres containing between 1 and 100% oxygen will be dominated by pseudomonads.
- Pseudomonads will cause putrid spoilage when their numbers exceed $10^8/\text{cm}^2$ on normal pH meat, or 10^6 cfu/cm² on high pH meat or fat.
- Pseudomonads may cause putrid spoilage even when they do not predominate on meat in atmosphere containing < 1% but not zero oxygen.
- The rate of growth of pseudomonads is halved in aerobic atmospheres containing 20% CO₂.

High Oxygen Modified Atmosphere Packs

- Carbon dioxide is absorbed by meat, so initial atmosphere should contain $> 20\%$ carbon dioxide.
- Oxygen concentration tends to fall over time, so oxygen concentration should be $> 50\%$.
- Nitrogen is inert, but some may be needed to prevent pack collapse.
- The volume of the atmosphere should be \geq twice the volume of the meat.
- Gas exchange between the pack atmosphere and air should be minimized.

Low Oxygen Modified Atmosphere Packs

- Cannot be used with red meats unless the atmosphere is supplemented with carbon monoxide.
- With carbon monoxide the colour is stable, but microbial spoilage is as in high oxygen atmospheres.

Zero Oxygen Modified Atmosphere Packs

- Vacuum packs or packs with oxygen depleted atmospheres of carbon dioxide and/or nitrogen.
- Meat has the colour of deoxymyoglobin unless the atmosphere before evacuation or the pack atmosphere contains carbon monoxide.
- Meat from zero oxygen packagings without carbon monoxide will bloom to a fresh meat colour when exposed to air.
- Meat from zero oxygen packaged primals cannot be repackaged in zero oxygen packagings unless carbon monoxide is used.
- Microbial spoilage will determine the storage life; and the display life if carbon monoxide is used.

Anaerobic Spoilage Flora

- Usually dominated by lactic acid bacteria of low spoilage potential.
- High pH product allows growth of enterobacteria and other organisms of high spoilage potential.
- An atmosphere of carbon dioxide will slow development of the lactic flora.
- With a lactic flora, the time to spoilage is ten times that for meat stored in air, and five times that for meat in a high oxygen atmosphere.
- Time to spoilage will reduce rapidly with increasing temperature.

The Ideal Modified Atmosphere Packaging?

Carbon dioxide 99.5 %

Carbon monoxide 0.5%



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