Improving efficiency and reducing waste in the beef supply chain

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Summary

- Waste
- Definitions
- Critical control points
- Nutrition
- Packaging
- Decision support tools
- Conclusion

Overview of waste in beef supply chain

- 570K tonnes of meat & fish wasted in the home
- retailer 'back of store' waste ~ 1.6 M tonnes of food per annum
- beef products discarded in UK prior to retail sale ~ 1600 animals equivalents/week

Farm | Abattoir & Processor | Central storage of Abattoir & Processor | Retailer's depot | Retailer's store

(WRAP, 2008)

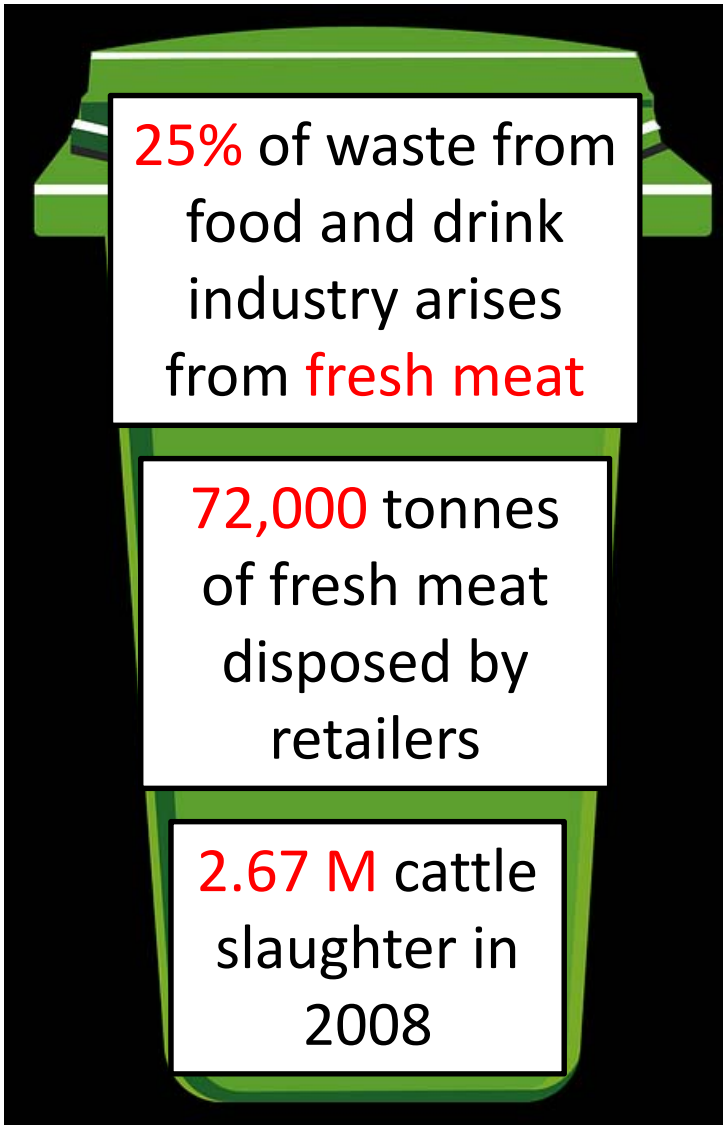
Definition and scale of waste - UK

Any substance or object the holder discards, intends to discard or is required to discard

EU waste framework definition

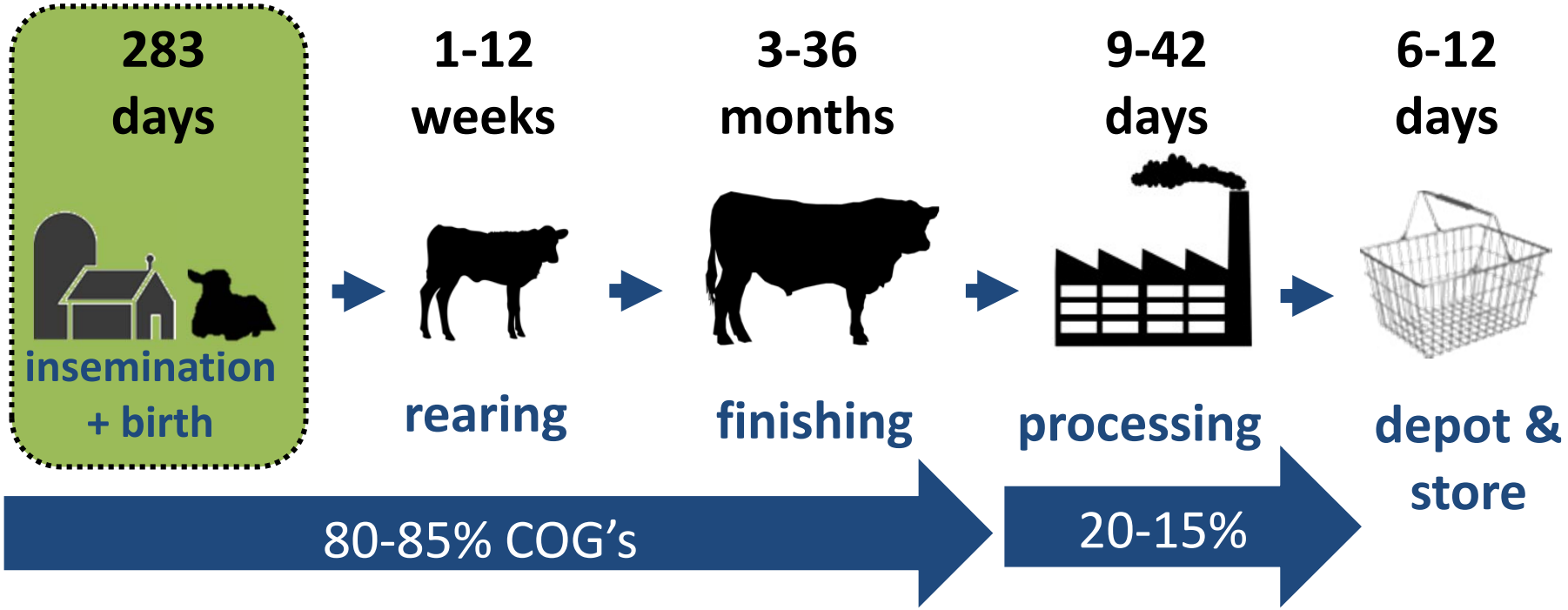
Any meat that is discarded or discounted

Meat industry definition



WRAP, 2011, WRAP 2010

Farm to retail sale

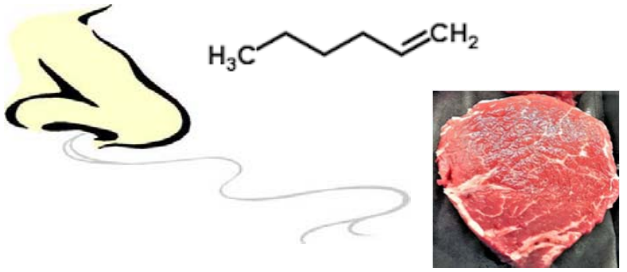


'Identification and rectification of factors that reduce quality and increase waste'

Causes of waste

Meat Colour

Off odours



Meat colour is a key determinant in consumer purchase decisions

Meat colour

Determined by:-

- Muscle micro-structure
- Concentration and oxidative state of haem pigments

Myoglobin (Mb) Haemoglobin (Hb)

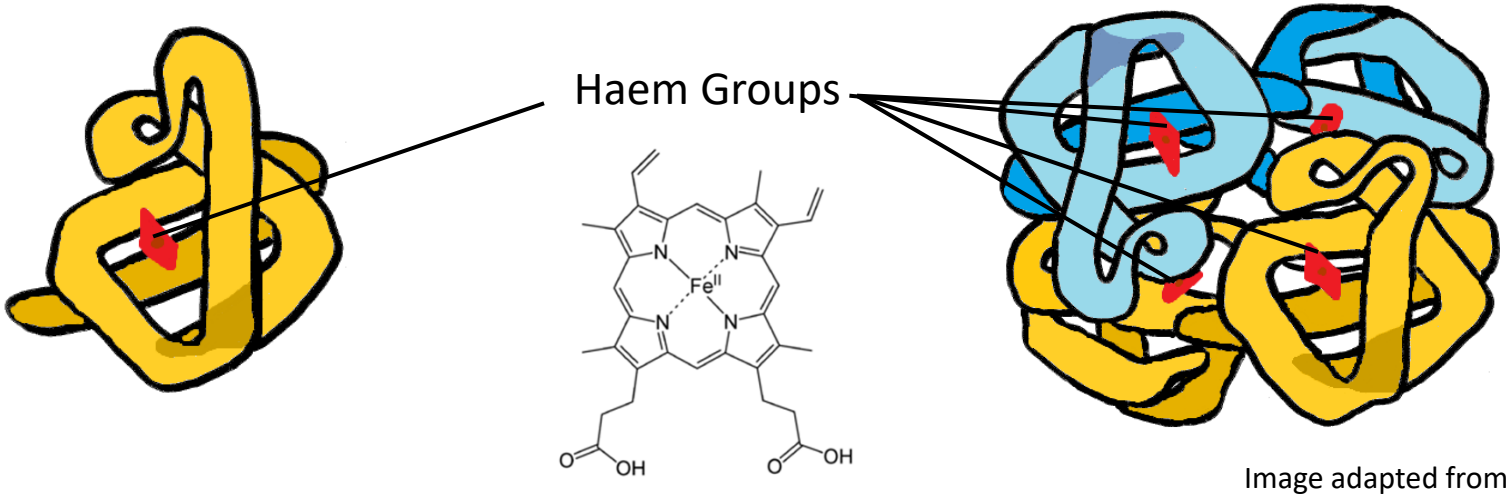
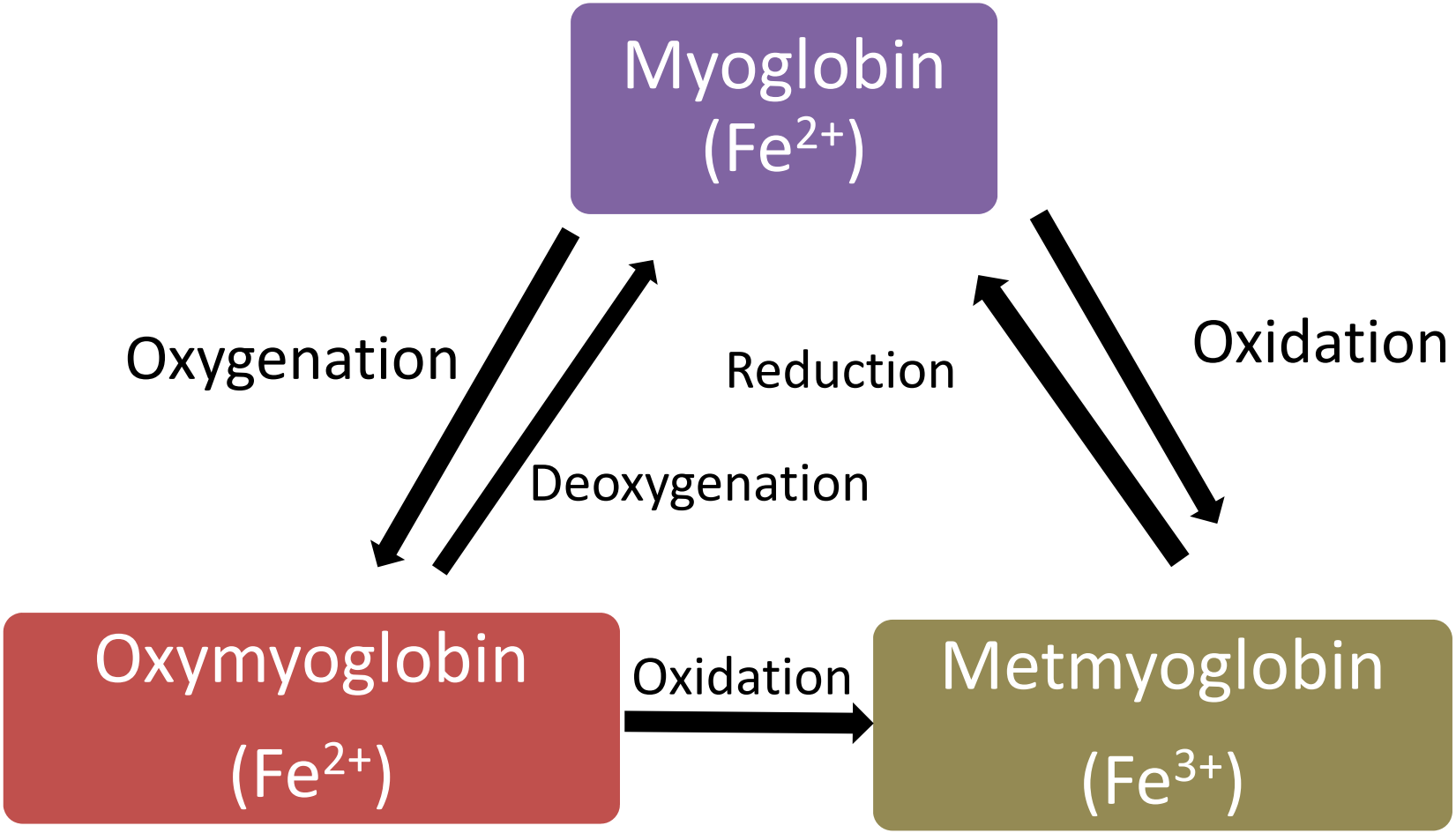


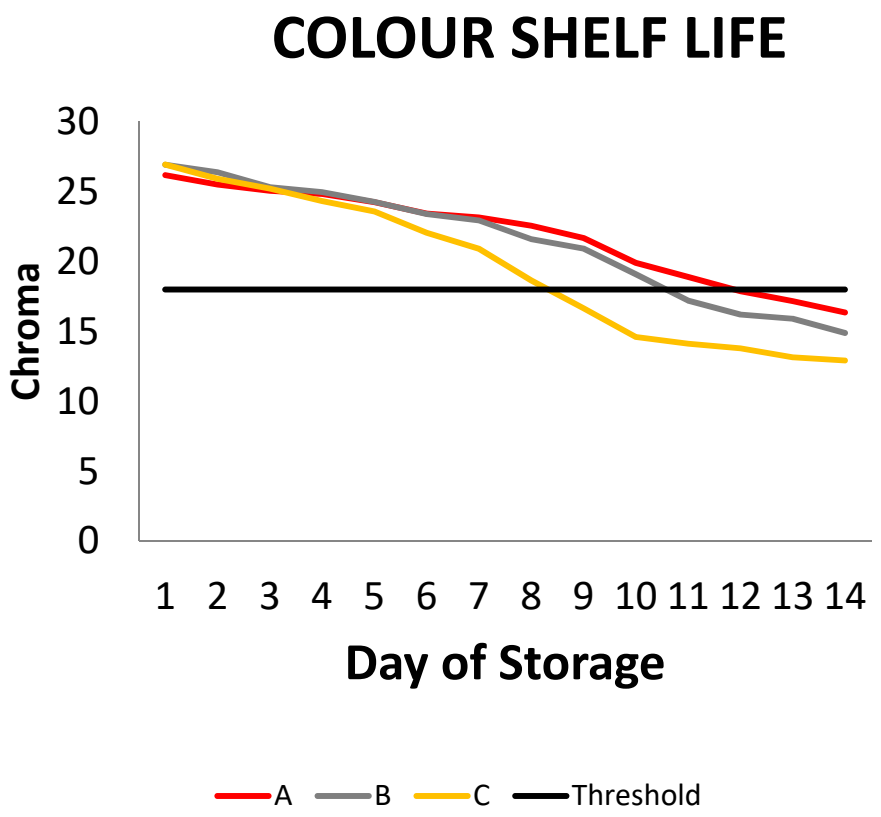
Image adapted from Williams 2015

Oxygenation and oxidation of myoglobin



Colour shelf life

- Meat colour can be measured using CIELAB system:
  - L*, a*, b* and saturation (chroma)
- Oxidation of 20% of surface pigment can be detected by a consumer
- This equates to a chroma measurement of 18 using the CIELAB system



(Warriss 2001, McDougall 1982)

Critical control points – shelf life

- Storage temperature
- Packaging
  - Overwrap
  - Modified atmosphere pack (MAP)
  - Vacuum skin pack

- Chemical composition of meat
  - ANIMAL DIET
  - Fatty acids
  - Antioxidants

Colour shelf life, physical and sensory attributes

PUFA

↓

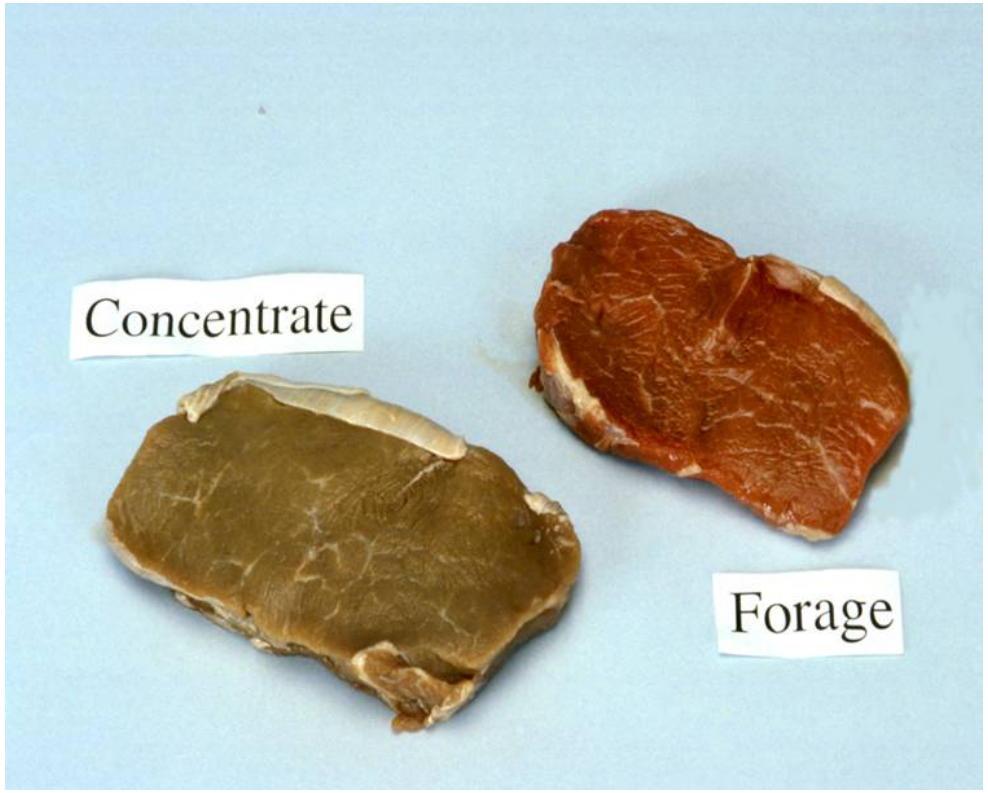
Lipid stability

↓

Colour shelf life physical and sensory

↑

Antioxidants



Antioxidants

- Antioxidants persist after slaughter
  - Tocopherol, carotenoids and flavonoids
  - Prevent oxidation of muscle lipids and oxymyoglobin

- 8 isoforms of vitamin E:
  - α-, β-, γ-, δ- tocopherols
  - α-, β-, γ-, δ- tocotrienols

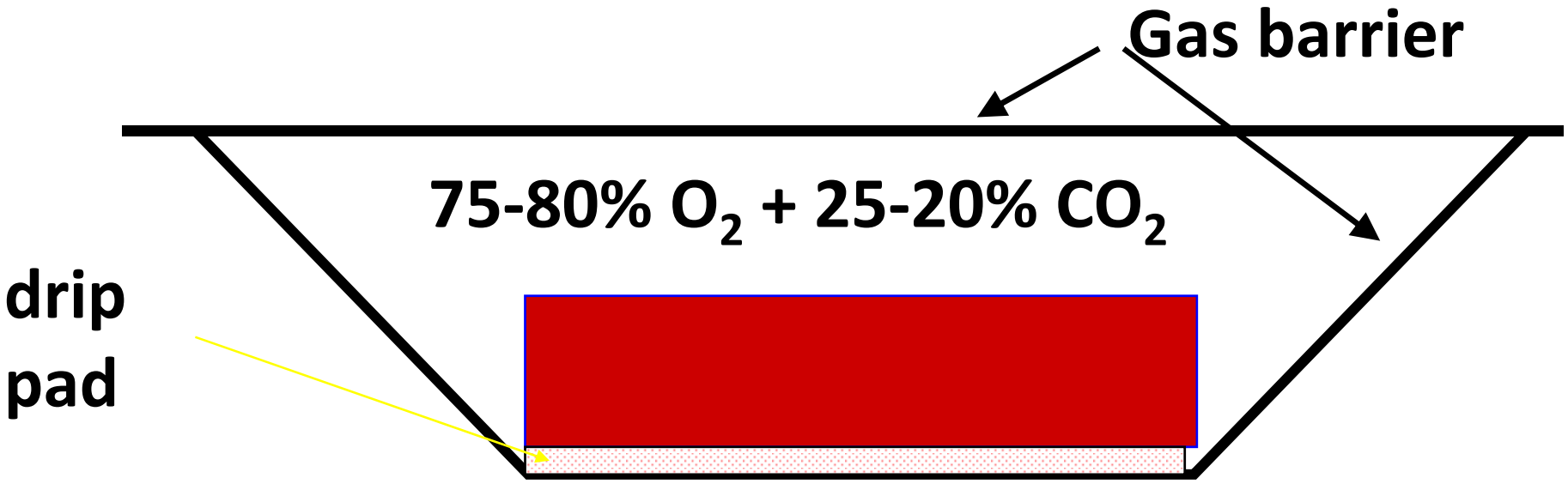
- α- tocopherol most effective when fed to the animal (basal diet; 300-1500 IU/d; time)

- target a muscle concentration of 3.3 – 3.5 mg/kg

Innovative packaging to extend shelf life and reduce waste

- modified atmosphere (MA) packs
- vacuum skin packaging (VSP)

Modified Atmosphere Packaging



Advantage: High oxygen gives increased colour shelf life, and carbon dioxide increased microbial shelf life

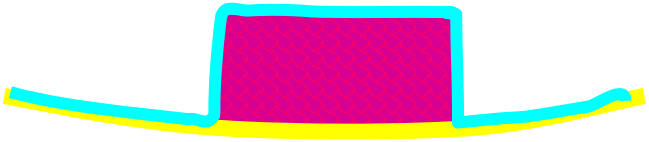
Disadvantage: Can increase lipid and protein oxidation

Vacuum packing retail portions

Vacuum Skin Packing seals meat portions between base film and of a heat-softened top film which is vacuum drawn onto the meat surface to give a skin-tight pack. No oxygen.

Gas impermeable

- no bloomed colour but 3-4 weeks life



Innovative packaging to extend shelf life and reduce waste

- ageing meat to improve tenderness shortens retail shelf life in modified atmosphere (MA) packs

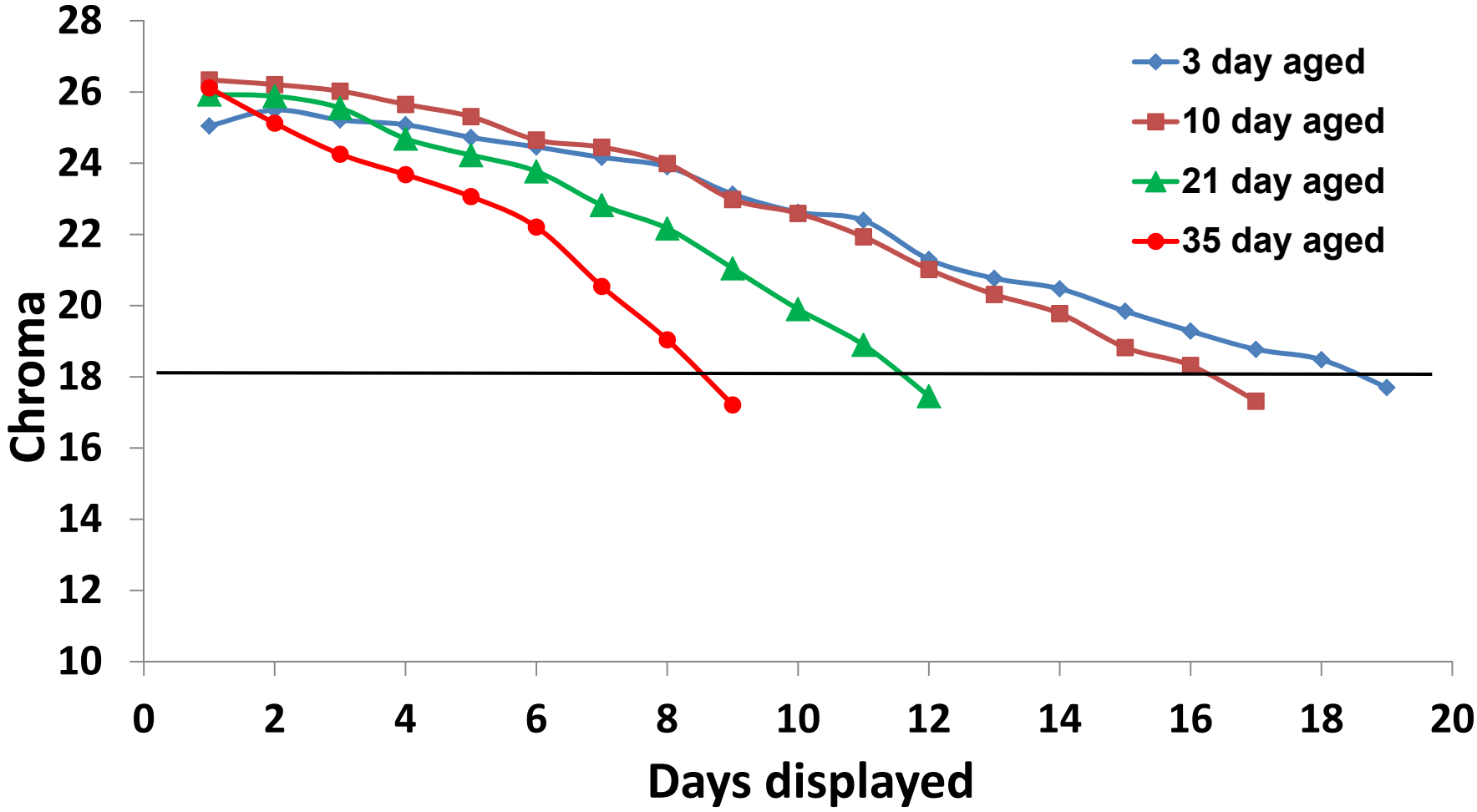
- not known if the same applies to vacuum skin packaging (VSP) ~ a particular problem of spasmodic premature browning with rump muscle

- effect of muscle type, ageing period, length and frequency of prior blooming on the colour stability of MA and VS packed meat

Points against high O_2

- Whilst high O_2 will retain the colour longer it does increase lipid oxidation when vitamin E is low and could contribute to WOF when cooked
- High O_2 -packed meat is less tender than vacuum packed, there is more protein oxidation
- Does this protein oxidation reduce tenderisation or cause toughening?
- Can you age meat first to make tender and then retain tenderness in high O_2
- What effect does Vitamin E concentration have?

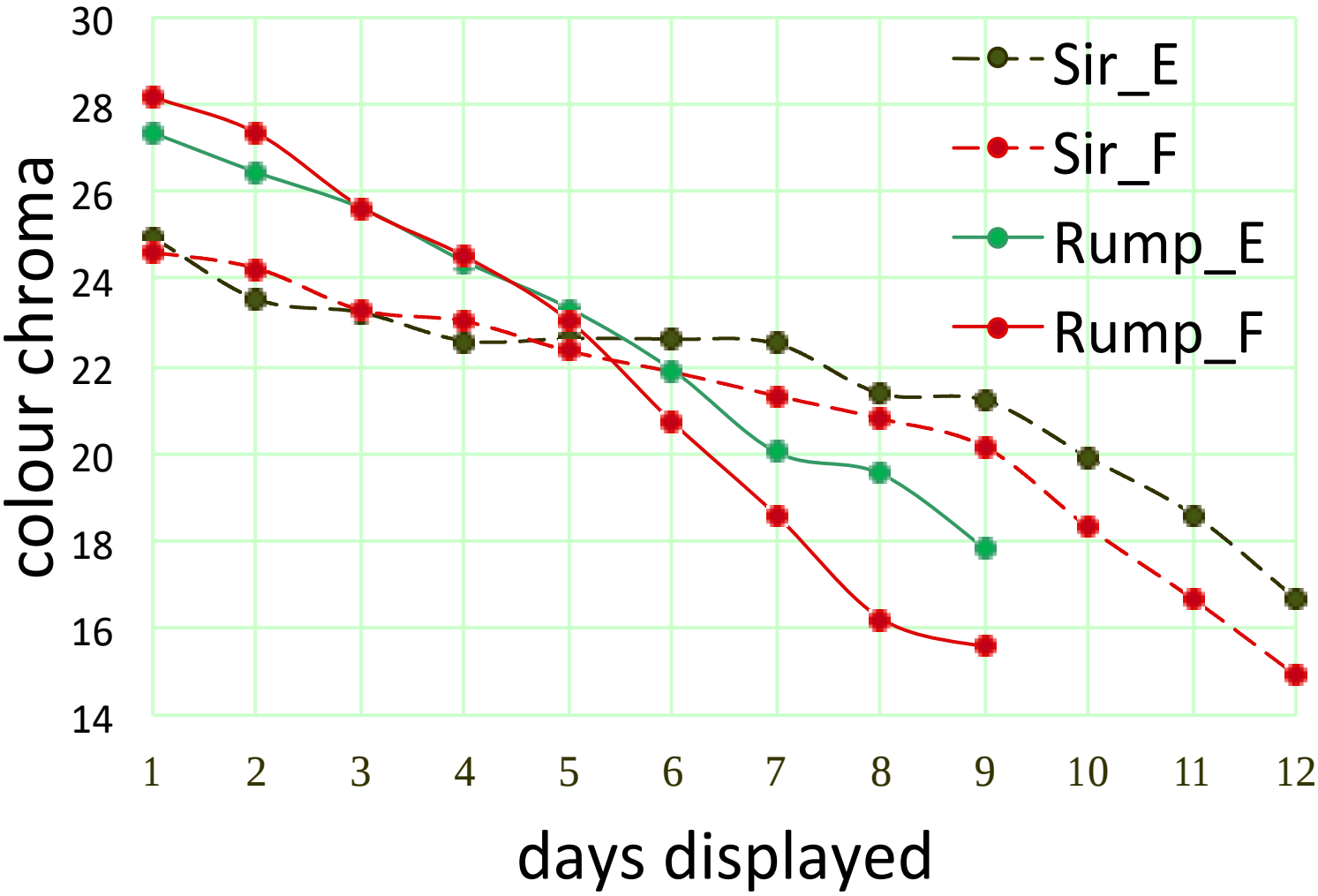
Days aged and subsequent shelf-life in MAP



Rump steaks after display in modified atmosphere for the same time period. Why has the one on the right discoloured?

Sirloin and rump steaks, 21 days in Darfresh™, opened and bloomed 1 hr

Vitamin E and colour stability of sirloin and rump steaks in MAP



Raison d'etre

- Part of the colour variation which occurs in retail packs is due to metabolic changes which affect the oxidation of pigments and compounds some of which can develop as a consequence of cutting and holding practices at the packing plant

- red meat often aged for 21 to 35 days

- this has the consequence of reducing retail shelf life in MAP most noticeable in red muscles which oxidise faster, e.g. rump

Overview of waste in beef supply chain

- Steaks, joints, diced, burgers, mince

- Identifying waste and root causes

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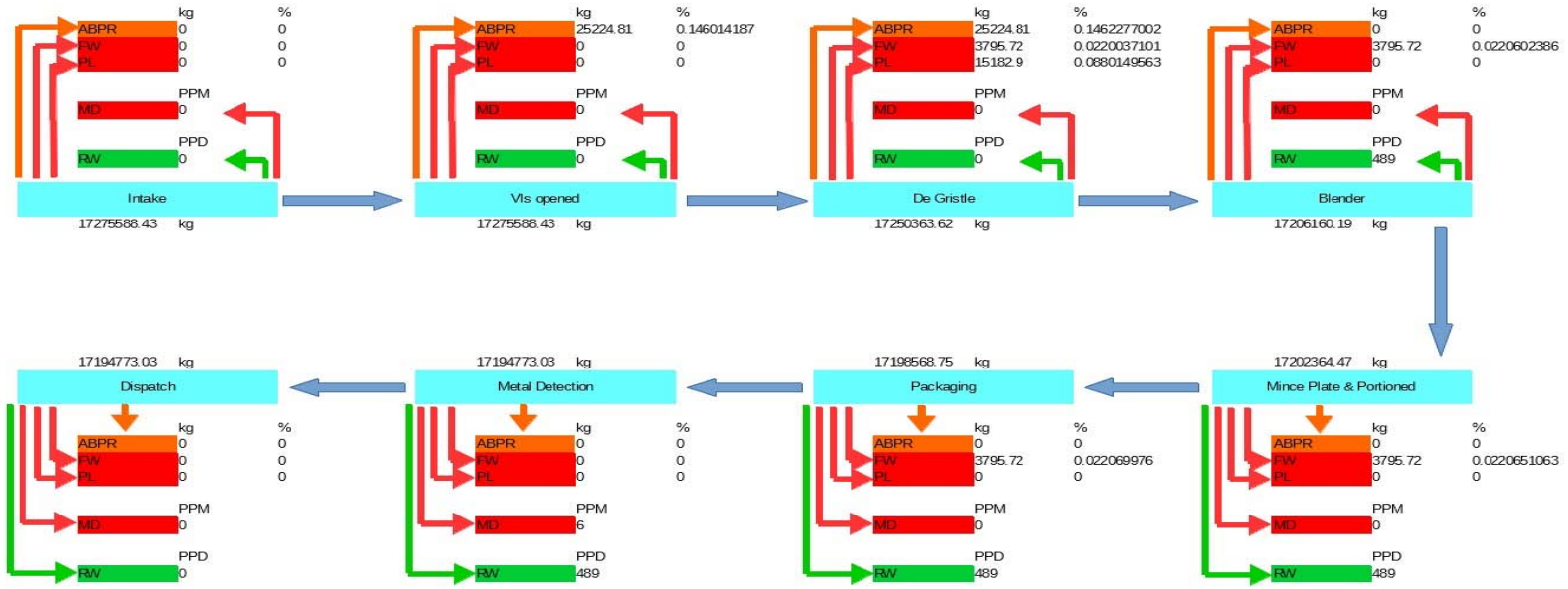
(WRAP, 2008)

Decision Support System (DSS)

- Map the entire beef supply chain and model the waste generated throughout the supply chain
- Identify hotspots of waste in whole beef supply chain, quantify the waste and prioritise the mitigation of waste hotspots
- Assist in improving the coordination within the whole beef supply chain
- Provide the real time solution for waste minimisation for all the stakeholders of beef supply chain

Prototype of Decision Support System

Waste in Mince process flow



Waste Categories:

- FW (Floor Waste)
- MD (Metal Detection)
- PL (Products left in De gristle Machine)

Animal By-products:

- Category 3

Rework:

- (Machine issue)

Reasons of waste in beef supply chain

- Expiry of shelf life of beef products prior to sale to consumers
- Premature discoloration and unusual odours are major reasons for rejection of beef products by consumers
- Error in forecasting the demand of consumers and lack of coordination in beef supply chain
- Beef products being damaged due to mishandling within the supply chain
- Lack of Decision Support System (DSS) to prioritise the mitigation of waste, linked with the root causes and assist in improving the coordination within the whole beef supply chain

Conclusions

- Identifying and addressing waste is a major issue
- Shelf life and odours
- Whole chain approach
- Interdisciplinary
- Underpinning and improve competitiveness of the UK beef supply chain

Acknowledgements

UK

Part of ABP Food Group