Food Quality Symposium

Milk and meat products quality (Sept. 1st)

Extending the shelf life of fresh meat

What is technically and legally feasible ?

Université de Liège

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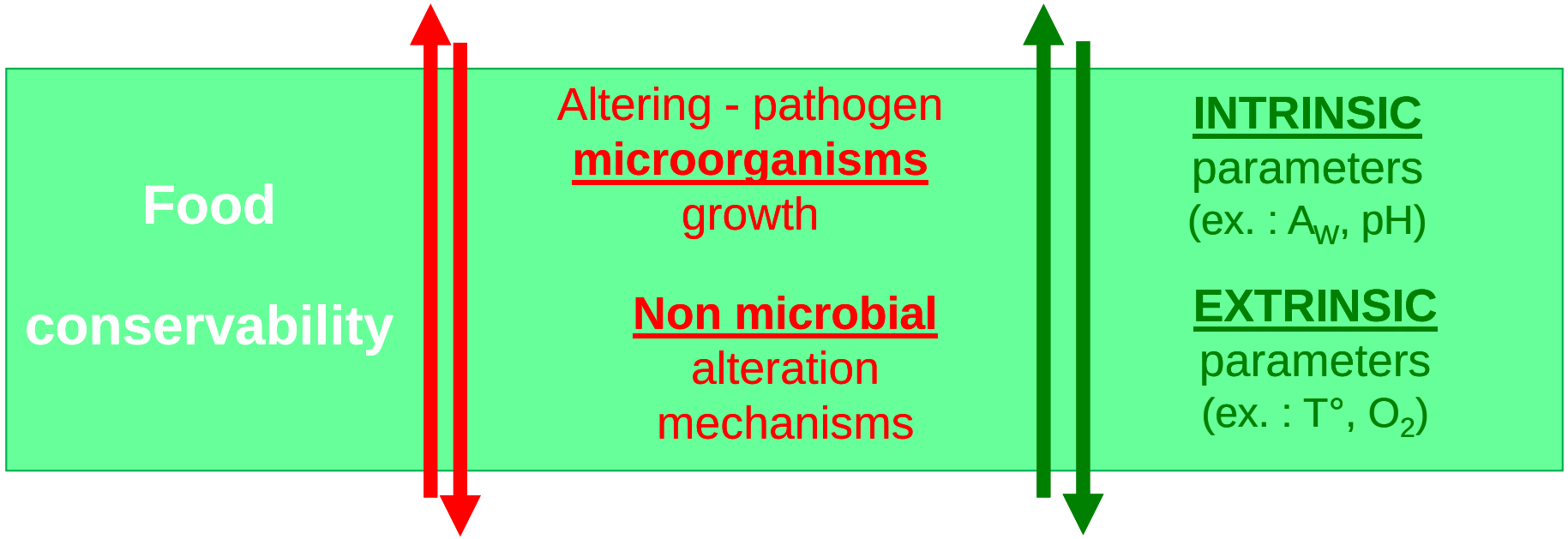
Content

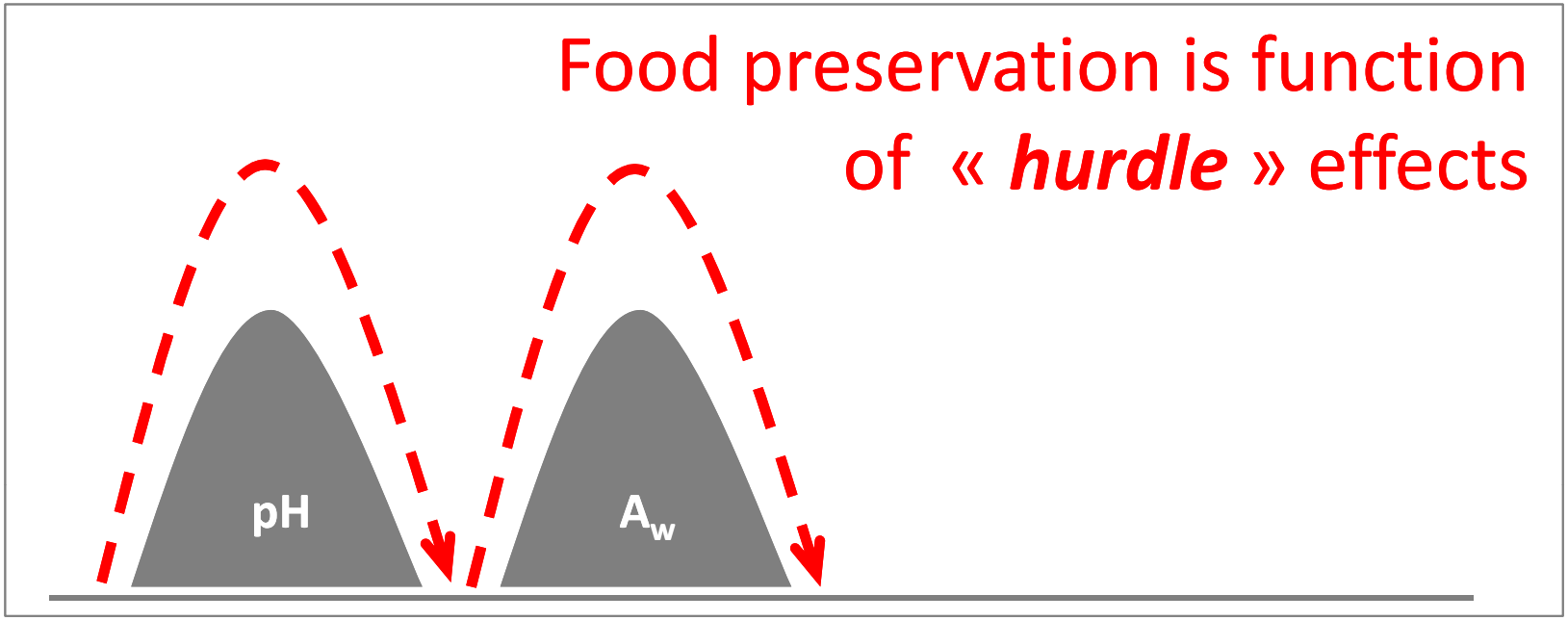
- Meat conservability
- What is technically feasible ?
- What is legally feasible ?
- What is technically and legally feasible ?
- Conclusions & Perspectives ?

Conservability ?



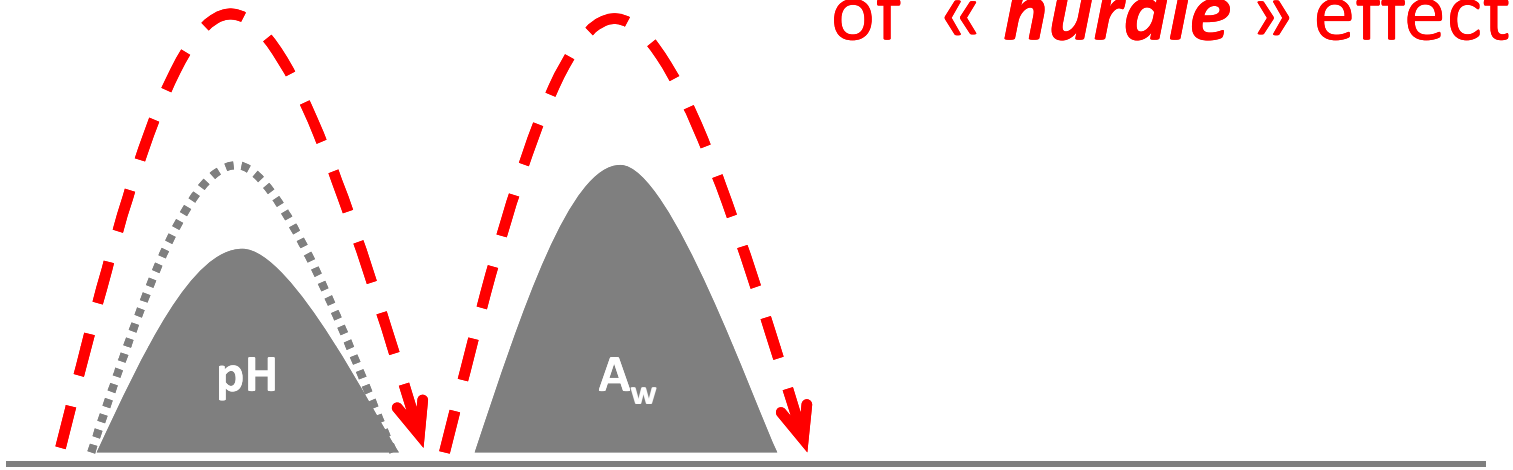
- Meat is highly **perishable**
  - pH = 5.5-5.8 / A_w = 0.99 (+ temperature)
    - ➢ **Microbial growth** (spoilage, hazard)
  - In presence of O_2 (+ temperature)
    - ➢ **Oxidation** (lipids, pigments, proteins)

Conservability ?



Conservability ?

Food preservation is function of « ***hurdle*** » effects



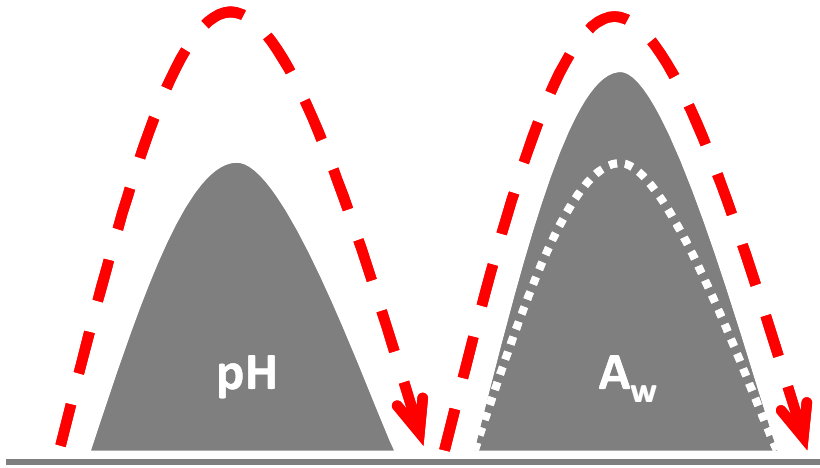
Source : A.C.

high pH meat (≥ 5.8)
= <u>lower</u> hurdle !

☹

Conservability ?

Food preservation is function of « ***hurdle*** » effects



Source : A.C.

Carcass surface : A_w ↘
= <u>higher</u> hurdle !

☺

What is technically feasible ?

- **Good Production/Hygiene Practices**
  - Initial meat quality & safety
- **Methods of preservation** (decontamination) ?
  - Removal of heat : chilling, freezing
  - Modification of atmosphere : vacuum, gas
  - Antioxidants : vit. E, plant extracts
  - Antimicrobials : organic acids, lactoperoxydase
  - Biopreservatives : protective flora, bacteriocins
  - Physical treatments : heat, irradiation, high pressure, …

What is legally feasible ?

- **Reglt (CE) N°853/2004**, Annex I, 1.10.
  - **Fresh meat** means meat that *has not undergone any preserving process other than chilling, freezing or quick-freezing, including meat that is vacuum-wrapped or wrapped in a controlled atmosphere*

What is technically and legally feasible ?

- **Good Production/Hygiene Practices**
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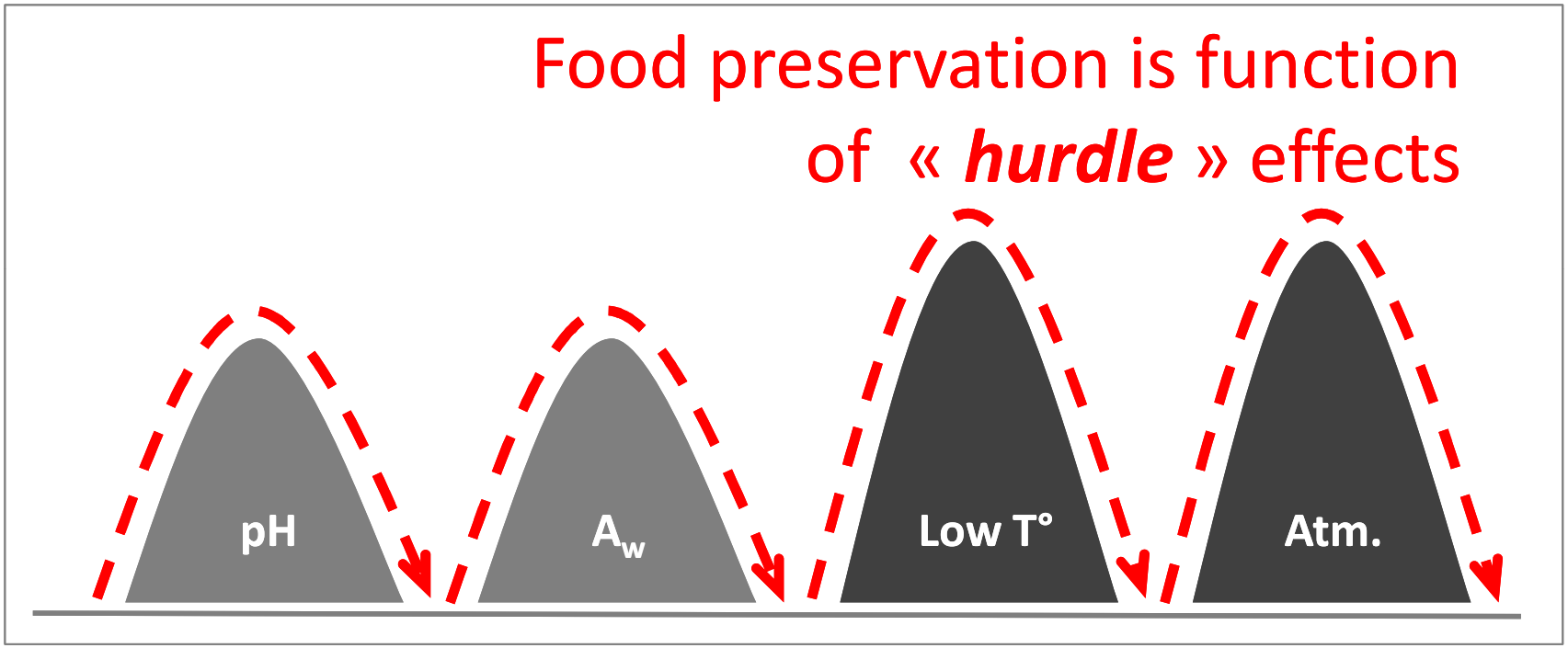
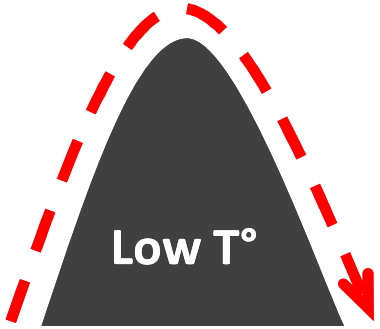
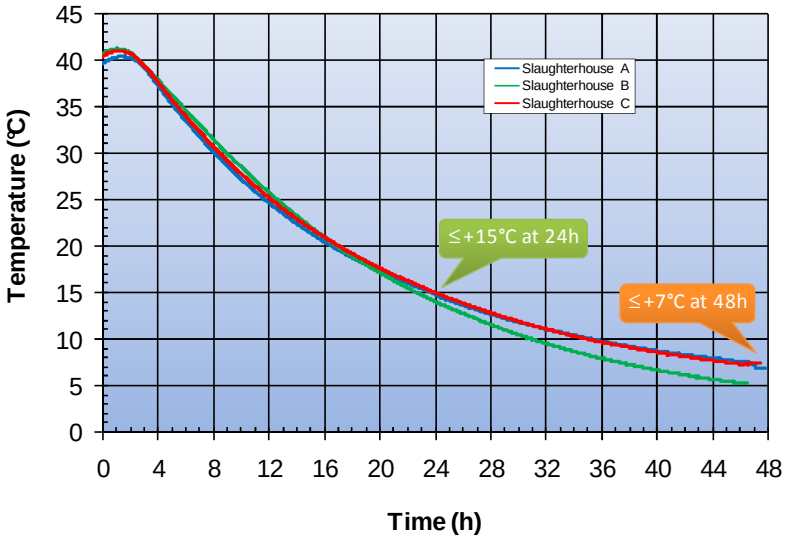


What is technically and legally feasible ?

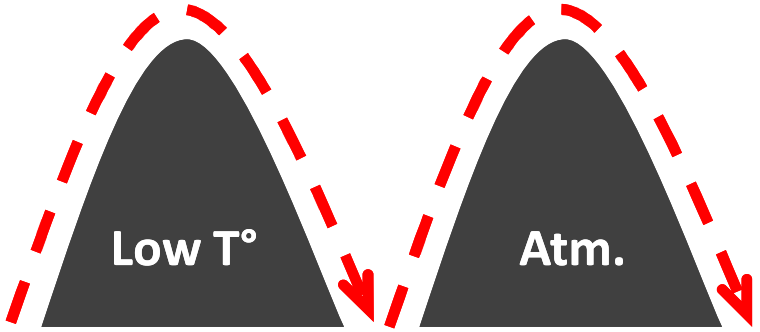


- **Carcass chilling**
  - L. Delhalle, B. Collignon, S. Dehard, P.H. Imazaki, G. Daube, A. Clinquart, 56th ICoMST, Jeju (South Korea), 15-20 Aug. 2010
    - 3 slaughterhouses
    - Belgian Blue double-muscled cattle (carcass weight ~ 480 kg !!!)



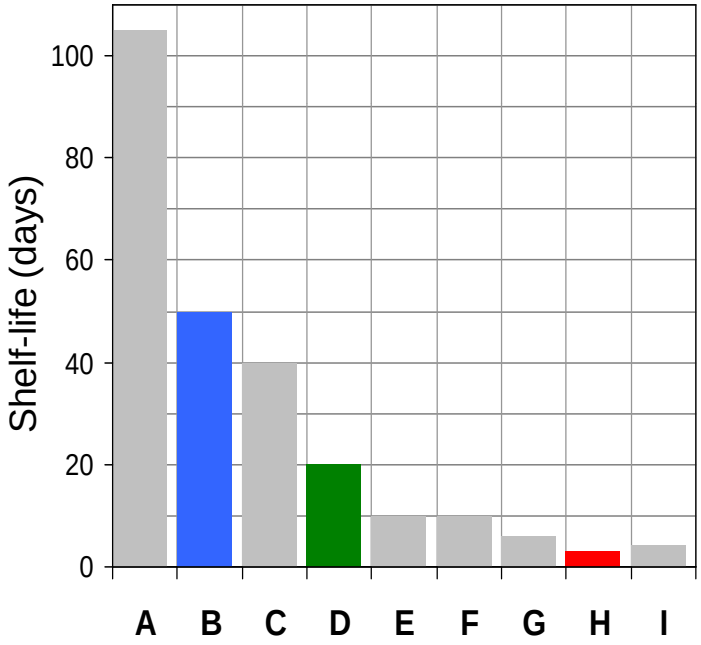
Recommendation	≤ +15°C
CSIRO, 1989	≤ 20h
Rosset & Rossel-Ciquard, 1984	≤ 24h

What is technically and legally feasible ?



Shelf-life for beef products as based on microbiological factors obtained with different combinations of gas atmosphere composition and temperature conditions

(Rönner U., 1995. Food Preservation by combined processes, Final Report FLAIR Concerted Action No.7, Subgroup B)



A = 100% CO_2, +1℃

B = **Vacuum, +1℃**

C = 100% CO_2, +4-5℃

D = **Vacuum, +4-5℃**

E = 10-20% CO_2 + 2-10% O_2 + N_2, +4℃

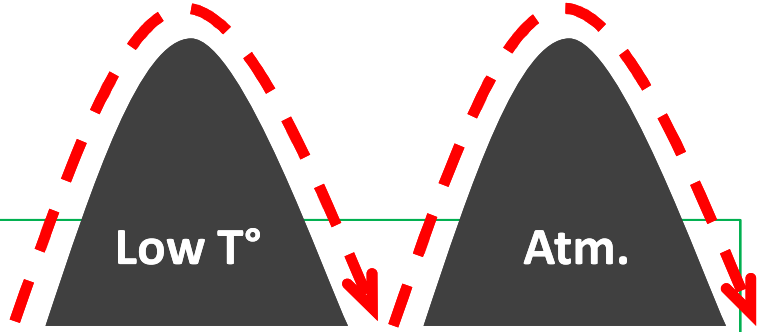
F = 15% CO_2 + 40% O_2 + 45% N_2, +4℃

G = 50-60% CO_2 + 40-50% O_2, +4℃

H = Air, +4℃

I = 100% O_2, 1-3℃

What is technically and legally feasible ?

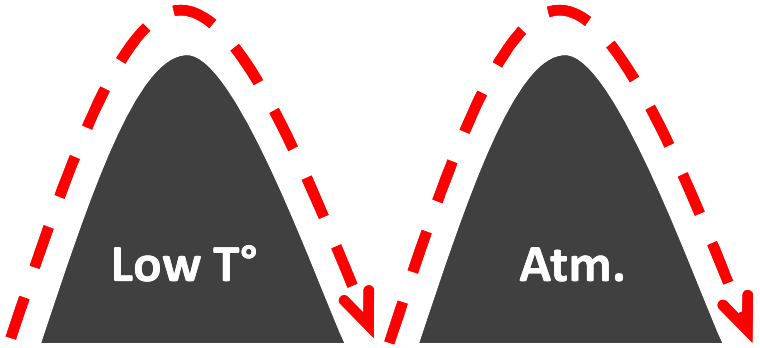


- **Fresh meat**

Vacuum		MAP (70% O_2:30%CO_2)	Air
			
Months at -1°C	Weeks at +4°C	1 week at +4°C	3-4 days at +4°C

Shelf life

What is technically and legally feasible ?



– Vacuum packed chilled beef : > 4 months shelf life at -1°C !?

- P.H. Imazaki, A. Maréchal, C. Nezer, B. Taminiau, G. Daube, A. Clinquart. 57th ICoMST (7-12 Aug., 2011), paper n°221
  - Chilled vacuum packed strip loins :
  - Storage :
    - » first 2/3 shelf life at -1°C
    - » last 1/3 shelf life at +4°C *vs* -1°C

Origin	Number of batches	Shelf life
Ireland (IE) and United Kingdom (GB)	3	35~45 days
Brazil (BR)	1	120 days
Australia (AU)	3	140 days

Months at -1°C

* satisfactory microbiological quality: < 6,7 log_{10} CFU/cm² LAB, < 3,7 log_{10} CFU/cm² *Enterobacteriaceae*, < 5 log_{10} CFU/cm² *Pseudomonas* spp. and < 5,7 log_{10} CFU/cm² *Brochothrix thermosphacta*

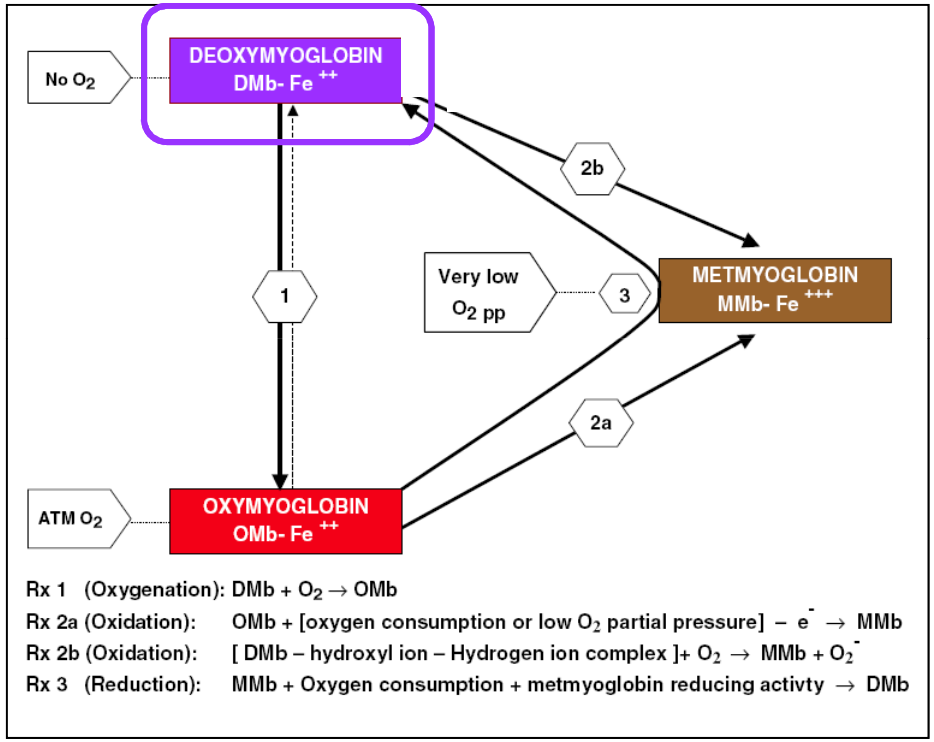
- » at **-1°C** : **satisfactory microbiological quality** ☺ ☺ ☺ ☺ ☺ ☺ ☺
- » at **+4°C** : Lactic acid bacteria and ***Enterobacteriaceae* growth**

Batch	IE1	GB1	GB2	BR1	AU1	AU2	AU3
	☹	☺	☹	☹	☹	☺	☺
Enterobacteriaceae (log_{10} CFU/cm²)	**4,5**	**3,3**	**5,7**	**4,2**	**4,3**	**3,6**	**<2,0**

What is technically and legally feasible ?

- **Color**
  - Industry
    - No oxidation
    - **Vacuum**
    - DMb-Fe^{++}

Weeks at +4°C

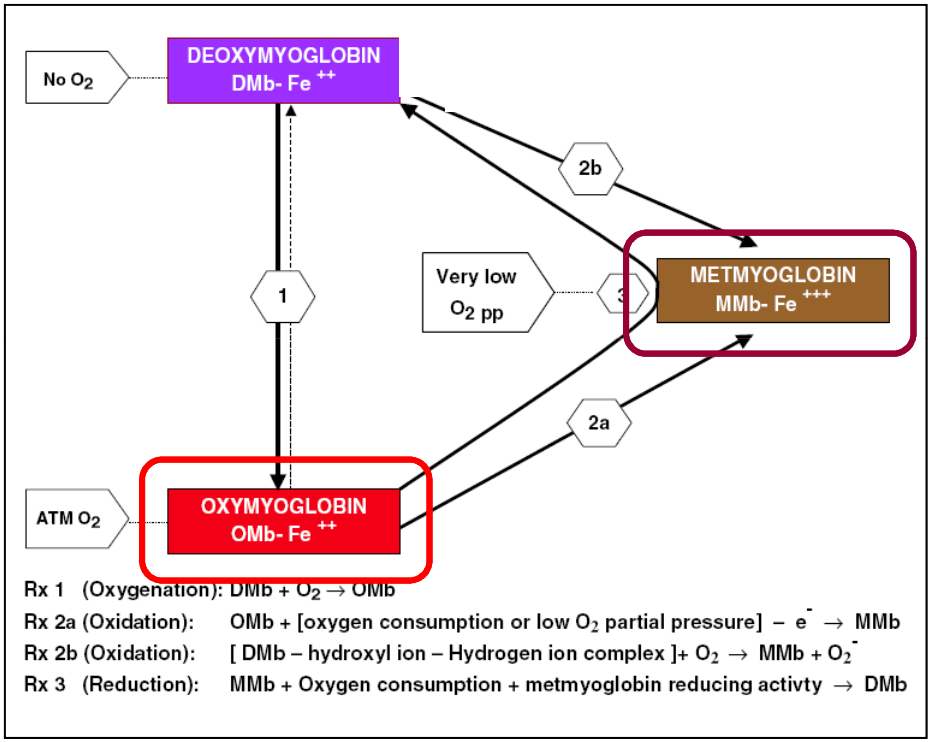


(Mancini R.A., Hunt M.C, 2005)

What is technically and legally feasible ?

- **Color**
  - Consumer
    - Freshness = red
    - **Atm. air** (21% O_2)
    - OMb-Fe^{++}
    - + MMb-Fe^{+++}

3-4 days
at +4°C

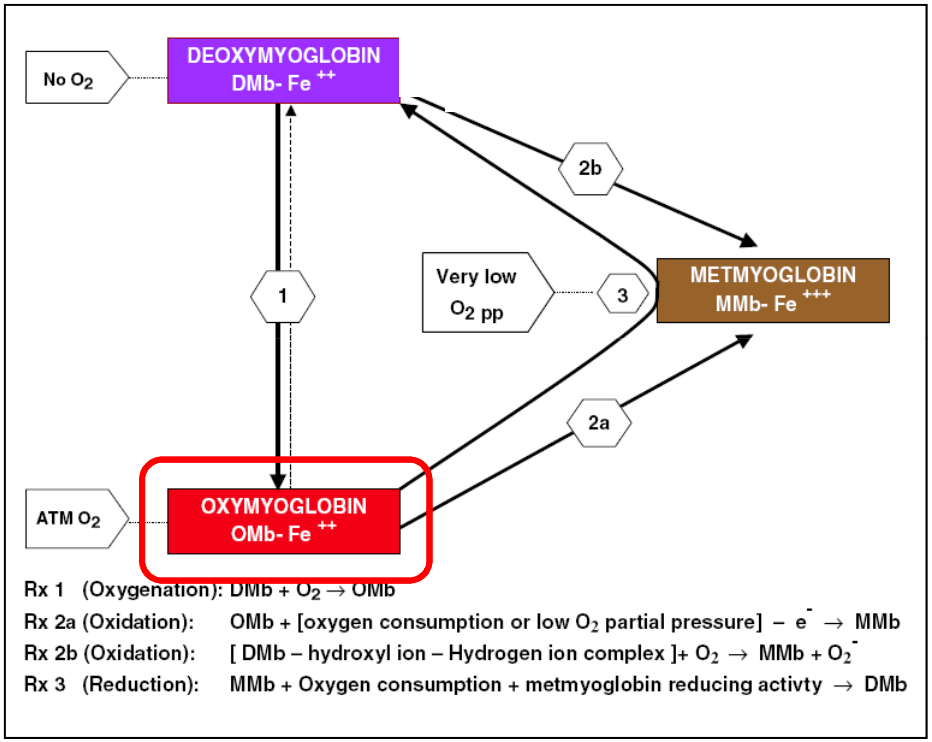


(Mancini R.A., Hunt M.C, 2005)

What is technically and legally feasible ?

- **Color**
  - Compromise
    - **M.A.P.**
      - 70-80% O_2 = OMb-Fe^{++}
      - 20-30% CO_2 >< bacteria
    - Freshness = red
    - but …
      - **+ aerobic flora**
      - **+ lipid oxidation**
      - **+ protein oxidation …**

1 week at +4°C



(Mancini R.A., Hunt M.C, 2005)

What is technically and legally feasible ?

- High O_2 M.A.P. **=> protein oxidation => …**
  - M.N. Lund, R. Lametsch, M.S. Hviid, O.N. Jensen, L.H. Skibsted. *Meat Sci.* 77 (2007) 295-303
    - Pork *longissimus dorsi* muscle
    - [70% O_2 : 30% CO_2 (■)] *vs* [vacuum skin packaging (•)]
    - Storage : 14 d at +4°C

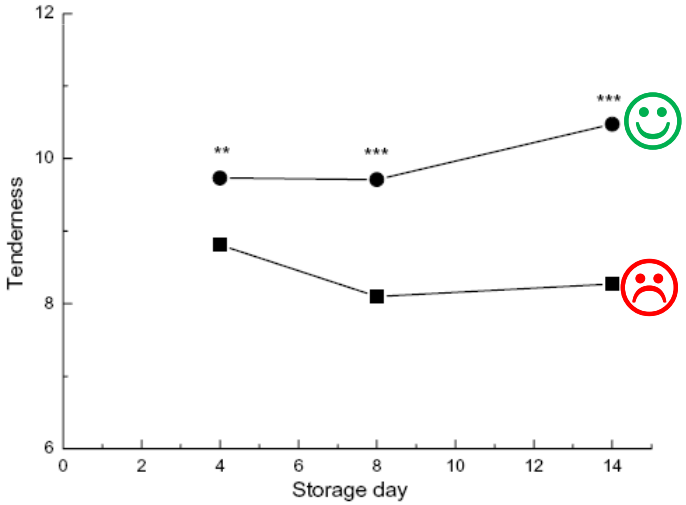


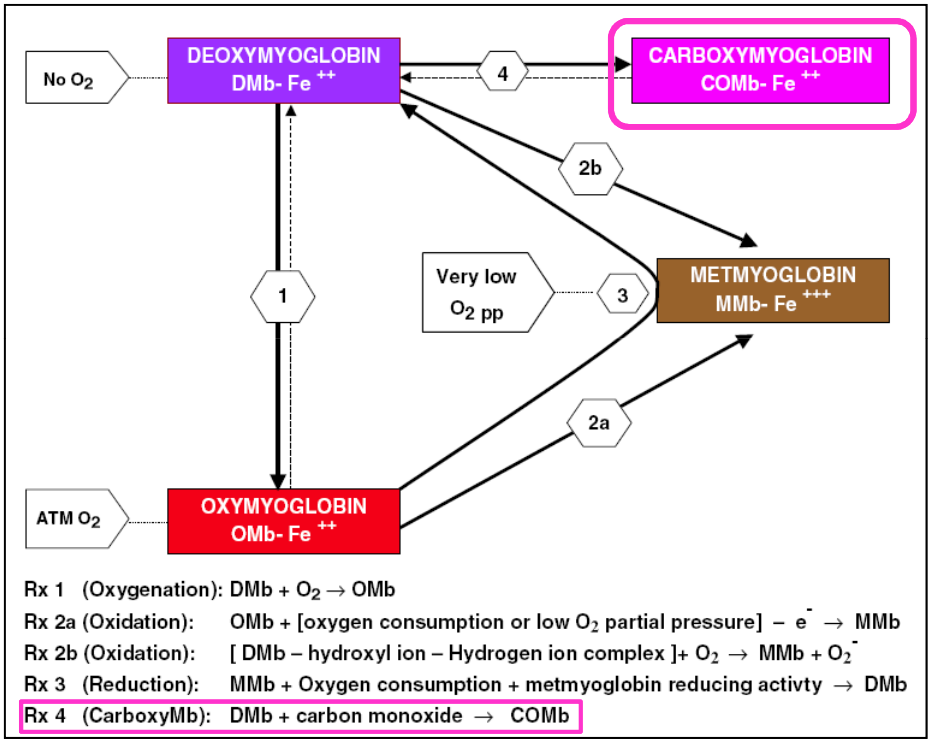
Fig. 1. Tenderness, juiciness, hardness determined by sensory analysis of LD slices stored in modified atmosphere (70% O_2/30% CO_2) (■) and skin packaging (●) for up to 14 days at 4 °C.

What is technically and legally feasible ?

- High O_2 M.A.P. and **previous ageing in vacuum packaging**
  - Frequently reported problem :
    - High sensitivity to **discoloration** ☹
    - Mechanism ?
      - » Antioxidant status of the meat ?
      - » Preslaughter stress ?

What is technically and legally feasible ?

– M.A.P. : **CO as alternative to O_2 ?**



(Mancini R.A., Hunt M.C, 2005)

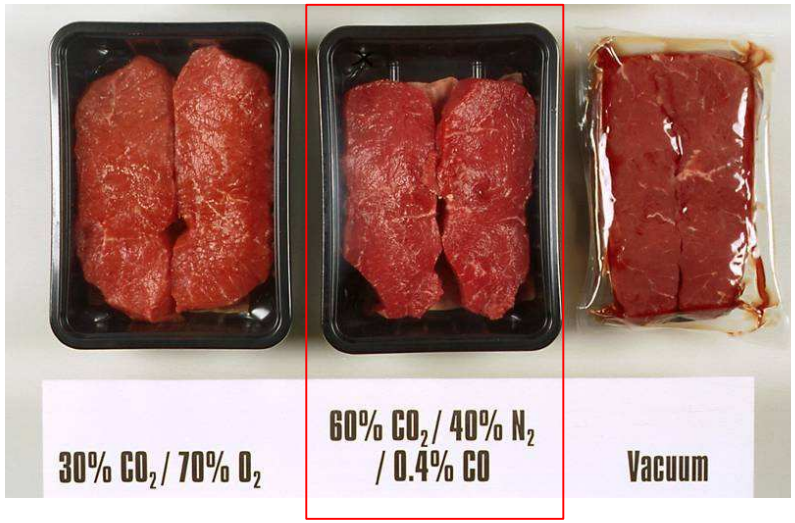
What is technically and legally feasible ?

– M.A.P. : **CO as alternative to O_2 ?**

- 0.3-0.4% CO = stable red color (MbCO) but no negative effect related to O_2
- Does not present a hazard to the consumer if < 1%
- Approved by some countries : USA f.e. (+ Norway)
- Not approved by EU : microbiological shelf life < color stability
- Adoption of EU regulations in Norway

Not approved by E.U.

(Courtesy, UECBV)



What is technically and legally feasible ?

– M.A.P. : **CO as alternative to O_2 ?**

- Martinez *et al.*, Meat Sci., 71 (2005) 563-570
  - Fresh pork sausage
  - Different atmospheres
  - Storage : 20 d. at +2°C, dark

Not approved by E.U.

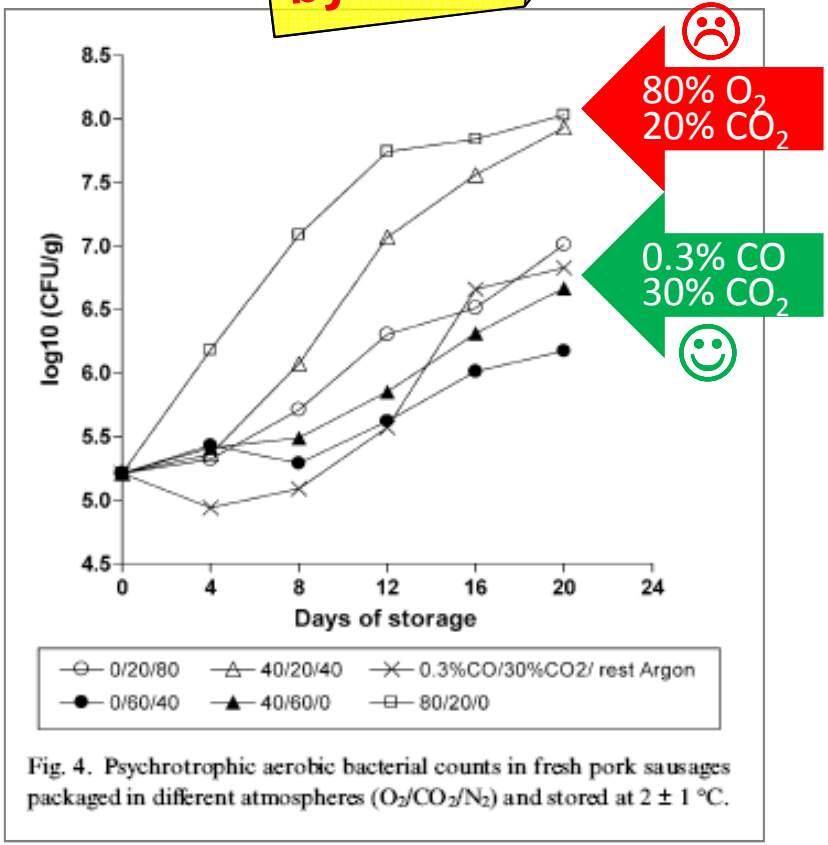


Fig. 4. Psychrotrophic aerobic bacterial counts in fresh pork sausages packaged in different atmospheres ($O_2/CO_2/N_2$) and stored at 2 ± 1 °C.

What is technically and legally feasible ?

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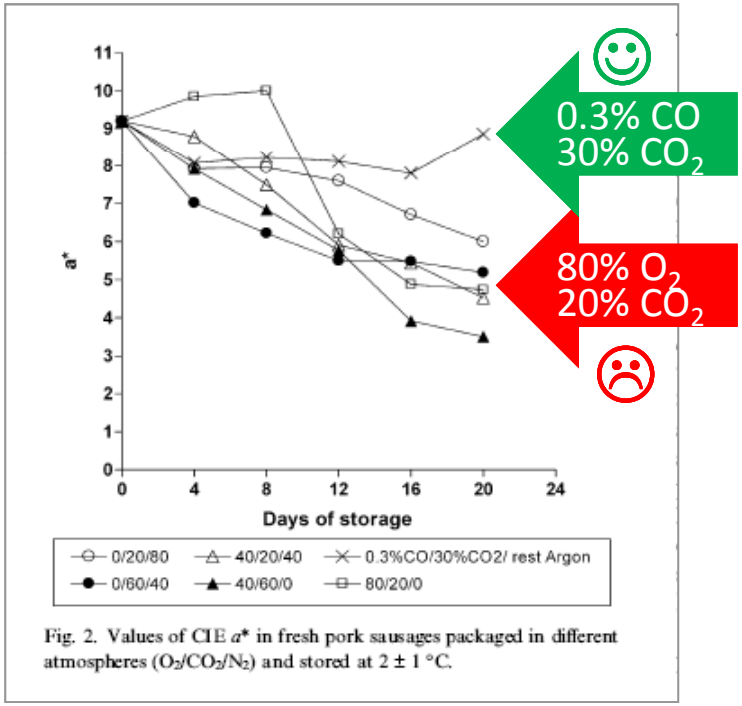


Fig. 2. Values of CIE a^* in fresh pork sausages packaged in different atmospheres ($O_2/CO_2/N_2$) and stored at 2 ± 1 °C.

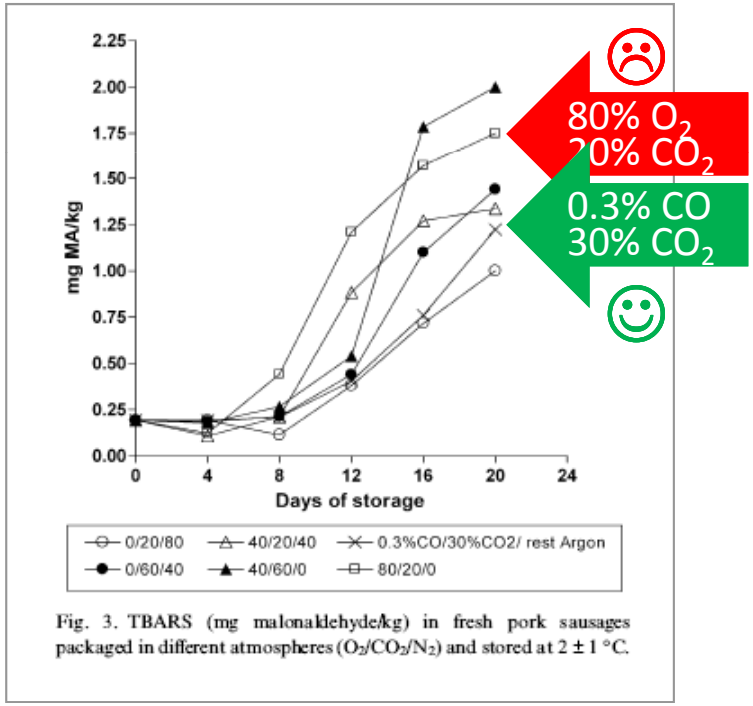


Fig. 3. TBARS (mg malonaldehyde/kg) in fresh pork sausages packaged in different atmospheres ($O_2/CO_2/N_2$) and stored at 2 ± 1 °C.

What is technically and legally feasible ?

- **Good Production/Hygiene Practices**
  - Low initial bacterial contamination
- **Methods of preservation** (decontamination) ?
  - Removal of heat : chilling, freezing
  - Modification of atmosphere : vacuum, gas
  - Antioxidants : vit. E, plant extracts
  - Antimicrobials : org. acids, lactoperoxydase
  - Biopreservatives : protective flora, bacteriocins
  - Physical treatment : heat, irradiation, high pressure, …

What is technically and legally feasible ?

– Antioxidants : **Vit. E** = in FEED => OK !!!

- I. Dufrasne , C. Marche , A. Clinquart , J.-L. Hornick , C. Van Eenaeme, L. Istasse. *Livestock Prod. Sci.* 65 (2000) 197–201

– Double-muscled Belgian Blue bulls
– [**C**ontrol group : 12,5 mg vit. E / kg conc.] *vs* [**V**it. E group : id. + 1000 mg/d]
– Storage : 14 d at +4°C, air, light

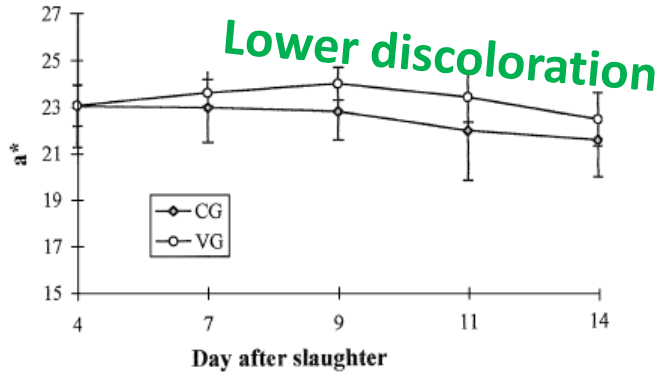


Fig. 1. Changes in redness (a^*) in m. longissimus thoracis for the control (CG) and vitamin E-supplemented (VG) groups.

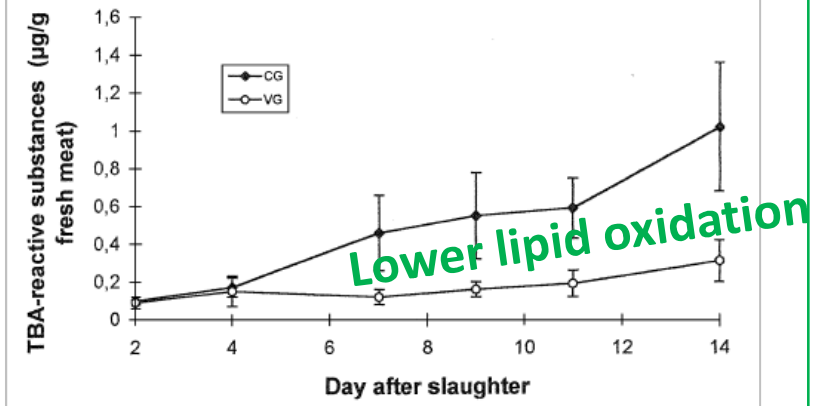


Fig. 2. Changes in TBA reactive substances over a period of 14 days of maturation in m. longissimus thoracis for control (CG) and vitamin-E supplemented (VG) groups.

What is technically and legally feasible ?

- Antioxidants : **Vegetal extracts** = in FEED => OK !!!
  - M. Gobert M., D. Gruffat, M. Habeanu, E. Parafita, D. Bauchart, D. Durand *Meat Sci.*, 2010, 85 : 676-683
    - Normande culling cows
    - Diet : [**C** : conc. + straw + extruded linseed and rapeseed] *vs* [**E** : id. + 155 UI vit.E/kg DM] *vs* [**EP** : id. + 7 g vegetal extracts rich in polyphenols / kg DM]
    - Packaging : [**V** : vacuum/14 d] *vs* [**A** : aerobic/4d] *vs* [**MA** : 70% O_2:30% CO_2 /7d]

Malondialdehyde concentration (µg/g tissue) in meat from *semitendinosus* (ST) and *longissimus thoracis* (LT) muscles from cows fed a concentrate and straw-based diet (70:30) su… 155 IU/kg diet DM) (**E**, $n = 5$) or with vit… in a tray under-vacuum packaging (**V**) … ass or 12 d ageing under-vacuum.

		MDA concentration (µg/g tissue)		
		Ageing in carcass		
Muscle	Diets	V	A	MA
ST	C	$0.17^{a,y}$	$1.20^{b,y}$	$2.85^{c,y}$
	E	$0.29^{a,y}$	$0.59^{a,y}$	$2.09^{b,y}$
	EP	$0.20^{a,y}$	$0.44^{a,y}$	$0.78^{a,z}$
LT	C	$0.19a^{,y}$	$0.67^{a,y}$	$1.64^{b,y}$
	E	$0.28^{a,y}$	$0.67^{a,y}$	$1.13^{a,y,z}$
	EP	$0.22^{a,y}$	$0.38^{a,y}$	$0.54^{a,z}$

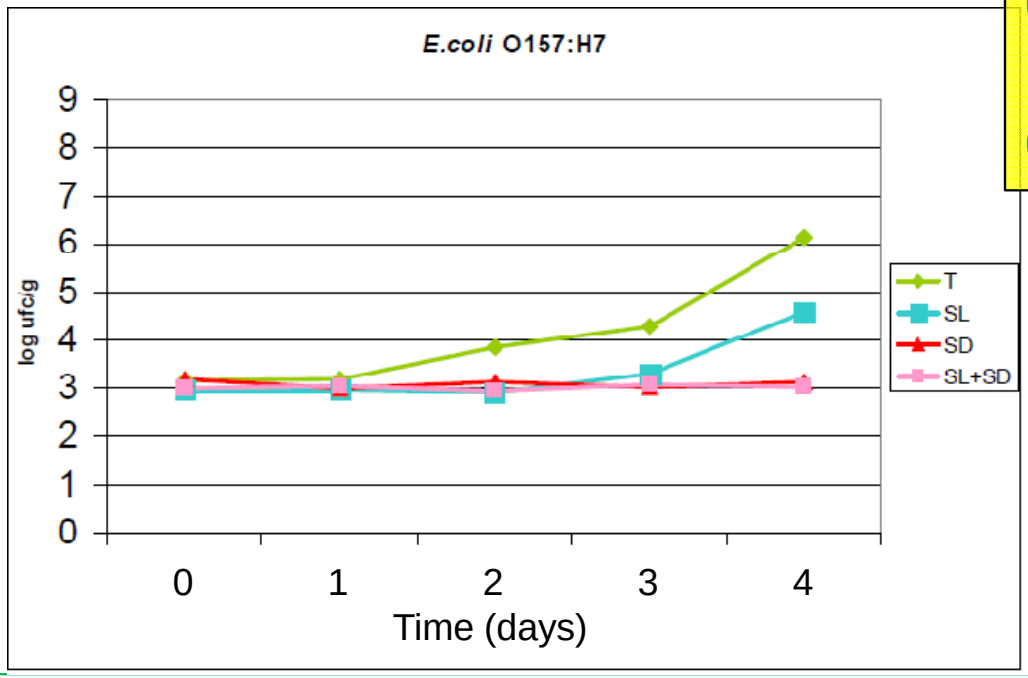
…tistical effect[A] … *P* values

Synergic effect of EP on lipid oxidation

What is technically and legally feasible ?

non approved in fresh meat !

- **Organic acids = food additives**
  - Clinquart *et al.*, unpublished
    - Beef minced meat, tray + stretch film
    - [Control (**T**)] *vs* [+ 1.5% sodium lactate (**SL**)] *vs* [+ 0.25% sodium diacetate (**SD**)]
    - Challenge-test with *E. Coli* O157:H7, 4 days at +10°C



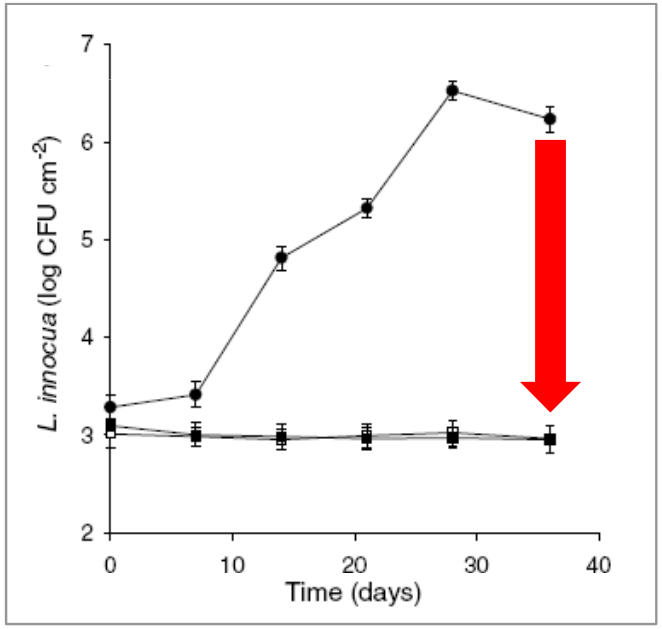
OK in … fresh minced meat
(Dir 2010/69 CE)

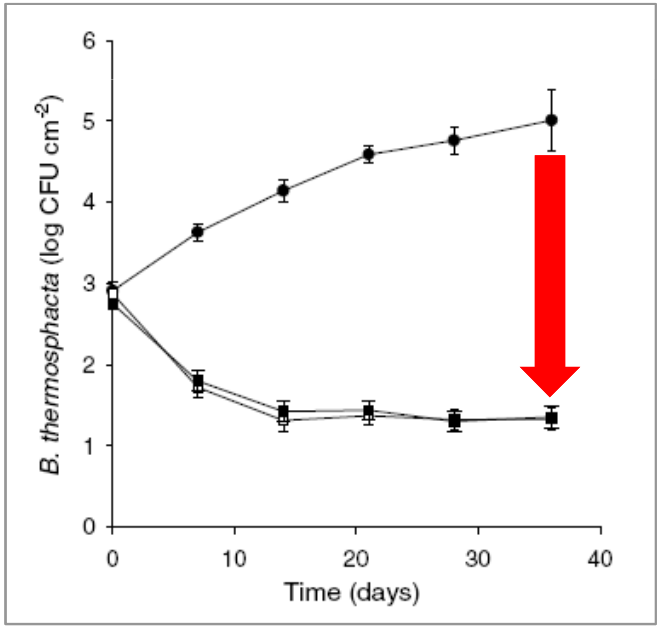
What is technically and legally feasible ?

– Bioprotective microflora = added ingredient

- Castellano P., Belfiore C., Fadda S., Vignolo G. *Meat Sci.*, 79 (2008) 483-499
  - Fresh bovine meat cuts
  - Control (•) *vs Lb. Curvatus* CRL705 (■) *vs* Lactocin AL705 (▫)
  - Storage : vacuum packaged, 36 d. at +2°C

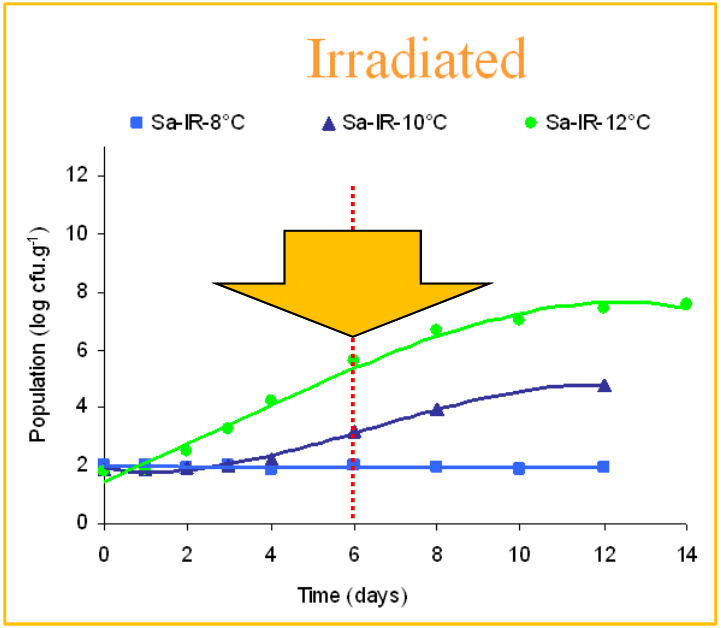
Not approved by E.U.

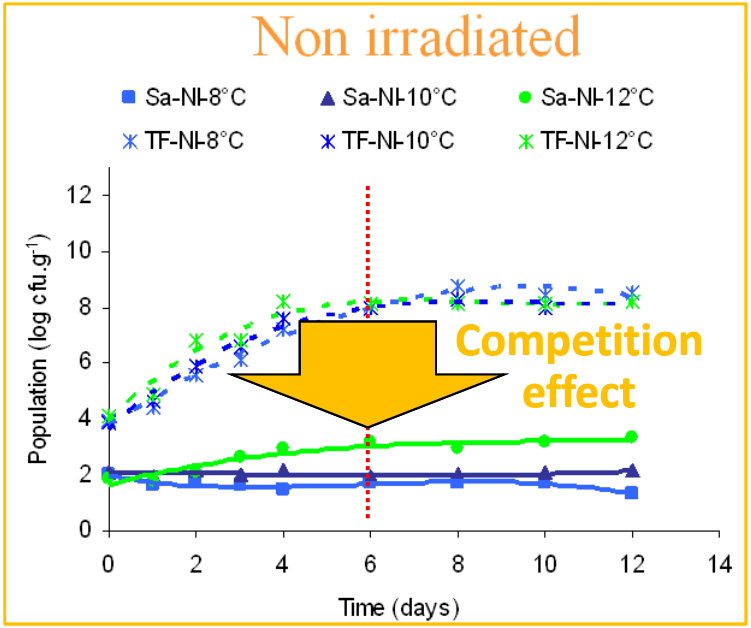




What is technically and legally feasible ?

- **Natural microflora** ≠ added ingredient ! => **OK !**
  - Y.Adolphe, L. Delhalle, A. Jasick, G. Boseret, R. Duré, G. Daube, A. Clinquart. Food Micro 2010, Copenhagen
    - Pork minced meat + *Salmonella* spp. (2 $\log_{10}$cfu/g)
    - [Irradiated (= **without natural flora**)] *vs* [Non irradiated (= **with natural flora**)]
    - Storage : MAP 70%O_2:30%CO_2, 12 d. at +8/10/12°C





Conclusions

- **The conservability of fresh meat is depending on :**
  - **Animal production**
    - Antioxidant status : muscle, feed, …
    - Preslaughter conditions : glycogen deposition, stress, …
  - **Meat technology**
    - Good Hygiene Practices
    - Hurdle strict control : temperature + atmosphere (+ *)

(*) In specific products : + some additives (organic acids, antioxidants), active packaging

Perspectives

New technologies	The Need for research
• **Organic acids**	Acid « Resistance » of bacteria ?
• **Carbon monoxide**	Pathogens control ?
• **Biopreservation**	Better knowledge of composition of the natural microbial flora and its dynamics during storage
• **High pressure**	Packaging (migration ?)
• **Active packaging**	≡ Food additives

Acknowledgments

- **EAAP2011 Organizing committee**
  - J.-F. Hocquette (Food Quality Symposium)
- **Région Wallonne (Be)**
  - DG Agriculture, Nat. Res. & Env. and DGO6
- **Univ. Liège / Dept Food Science** (www.dda.ulg.ac.be)
  - P. Imazaki, L. Delhalle, Y. Adolphe, R. Duré, G. Daube

Wallonie





The University of Liège in collaboration with the UECBV
is organizing on

Thursday 13th October 2011, in Brussels, a Seminar on:

MEAT SAFETY: *"PREVENTION IS BETTER THAN CURE"*

Animal health strategy quote

E-coli, Campylobacter, Listeria,... food microbial contamination incidents call for an improvement of the existing preventive measures.

Scientists, EU institutions representatives, Member States competent authorities and red meat industrials will be invited to meet and discuss how to tackle the anti-microbial treatments (AMT) issue.

How can we take the fight for food safety to the next level?

***

Further information will follow – for the time being

SAVE THE DATE

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