Packaging for fresh convenience food

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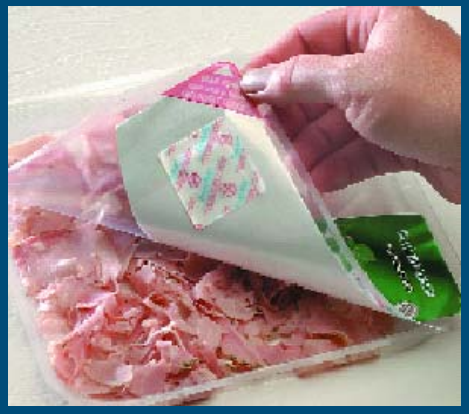
Fresh cut food products – *Dutch perspective*

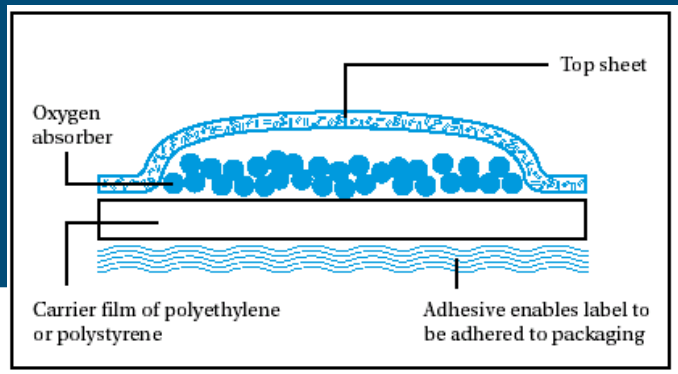
- Important
  - Largest source of income for Dutch retail
    - Fresh turnover 10 B€
    - Fresh cut greens turnover > 750 M€ in 2005, +14% /yr
  - Traffic generator
  - Trends:
    - Fresh = healthy, tasty, convenient
- Complex
  - Fresh produce lives
  - Quality varies > 100%
  - Sourcing issues
  - Large portfolios
    - 100-250 fresh cut fruit and vegetable products / shop

Protective packaging technologies in Europe

- Currently applied
  - MAP
    - meat, fish, meals, cheese...
  - E-MAP
    - Fruit, vegetables & soft cheeses
  - Vacuum
    - Meat, cheese, technical parts

- Hardly applied
  - Active packaging
    - oxygen scavengers
    - flavour release





History of meat packaging in NL

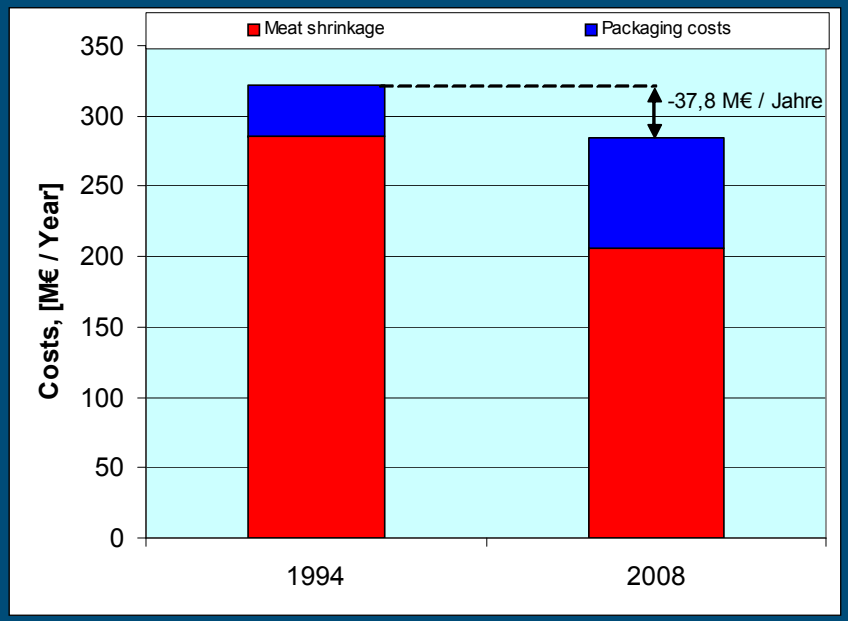
- 60's
  - Supermarkets expand
  - Meat is pre-packed
    - White styrofoam tray
    - PVC stretch

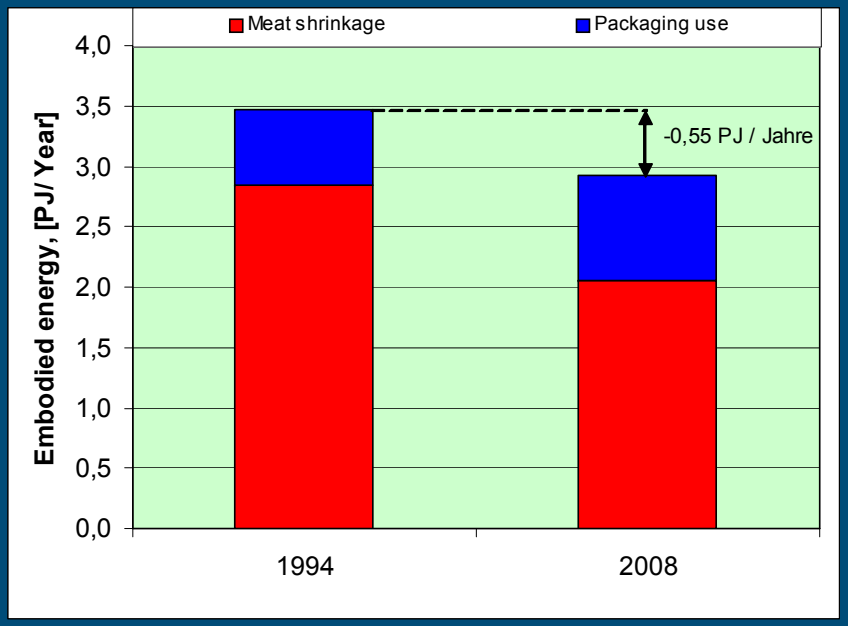
- 1964 first tests MAP
- 1975 Begin MAP
- 2000 Break through MAP
  - Large retailers start
- 2007: 50 % MAP

Modified atmosphere packaging for meat

- Higher direct costs +0,07 €/pack
  - Packages
  - Gasses, machines…
- Lower indirect costs <-0,10 €/pack
  - Longer shelf life
    - Less shrinkage in shops (8 - 10 -> 4 - 5%)
    - Less night shifts
    - Lower delivery frequency ….

Balances





Financial: -37.8 M€ / Year

Environment: -0.55 PJ / Year

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MAP for RTH meals

- Cook and Steam meals
  - Double fresh dilemma
    - 5 days shelf life -> 20% shrinkage -> 5 €/meal
  - Solution:
    - E-MAP + protective meat marinade + quality oriented sourcing -> 9-10 days

- Post-pasteurized meals
  - Improve taste & appearance
    - New packaging technologies:
      - Oxygen absorbers
    - New pasteurisation technologies
      - HPP

New opportunities for MAP

- Extending shelf life of oxygen sensitive foods:
  - New materials with lower OTR @ 7°C and 100%RH
  - Using more effective gas packaging machines
  - Using oxygen absorbers
- Bio-barriers
  - Bio-degradable barrier films are starting to appear

Packaging technologies for fruits and vegetables E-MAP & AE-MAP

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Respiration

- Complex
- From 1 to 300 ml O_2/kg.hour

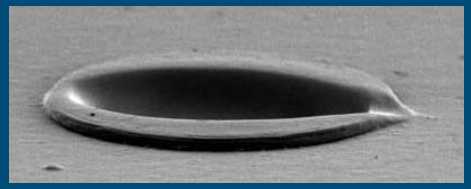
$$R_C = K_1 \cdot \exp\left(\frac{-E_a}{R \cdot T}\right)\{1 + K_2 \cdot \exp(-k_d \cdot t)\}$$

$$vO_2 = v\max O_2 \times \left[\frac{O_2}{(KmO_2 + O_2) \times (1 + \frac{CO_2}{KmnCO_2})}\right]^x$$

$$V_{CO2} = RQ_{ox} \cdot V_{O_2} + \frac{Vm_{CO_2(f)}}{1 + \left(\frac{O_2}{Kmn_{O_2(f)}}\right)}$$

- Flow-packs (20 x 30 cm):
- -> 300 – 100.000 ml O_2/m².bar.day
- -> 500 – 300.000 ml CO_2/m².bar.day

- Mostly used solutions
  - BOPP/CPP/AF + micro-perforations

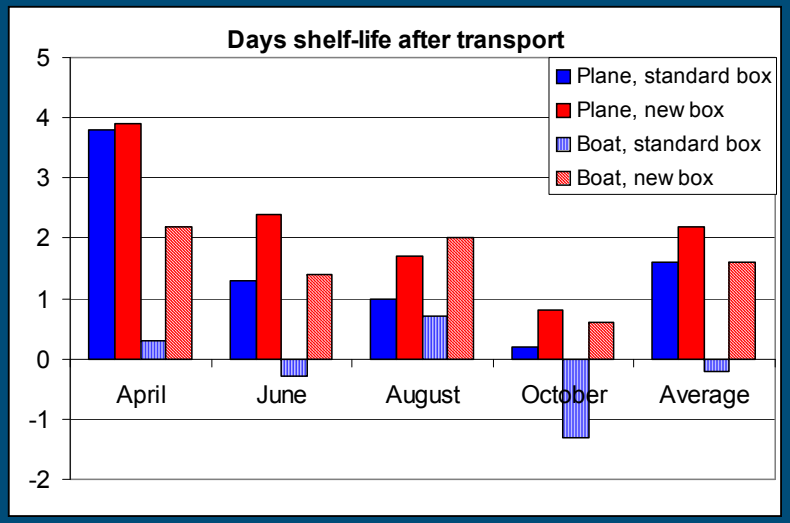


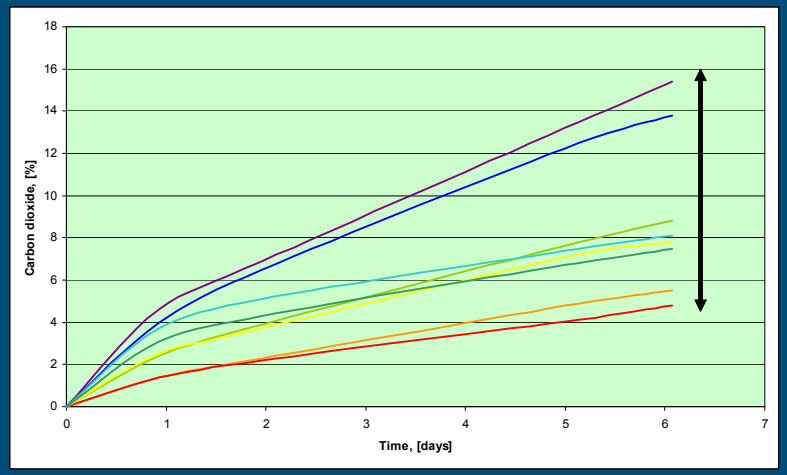
Transpiration

- Shriveling or Fungal infection
- Production: 0,001 - 0,1 g H_2O/kg.hour
- Ideal RH%
  - 100% Cucumbers -> PE Shrink film
  - 85% Bell-peppers, tomatoes -> macro-perforated films
- Polyolefin films have much too low WVTR for most products
  - Micro-perforations do not help: ~2 mg/day.hole of 100 µm Ø

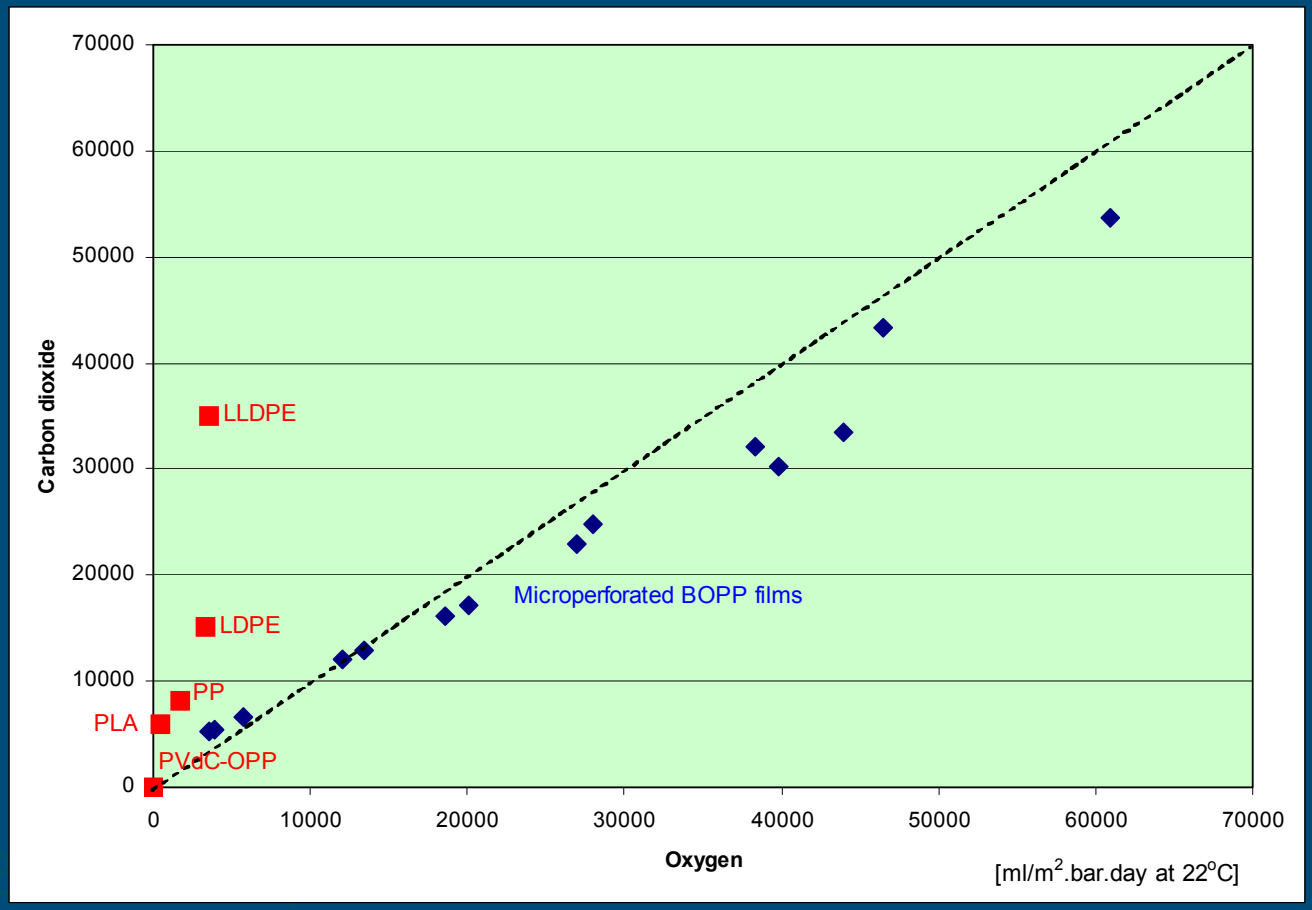
Variation in quality

- Large difference between reality and theory (Literature)
- Variations of >100% in:
  - Microbiological load
  - Respiration activity
- Origin, harvest method, growing conditions, seed type….
- Simultaneously:
  - Control the initial quality and
  - Optimise packaging

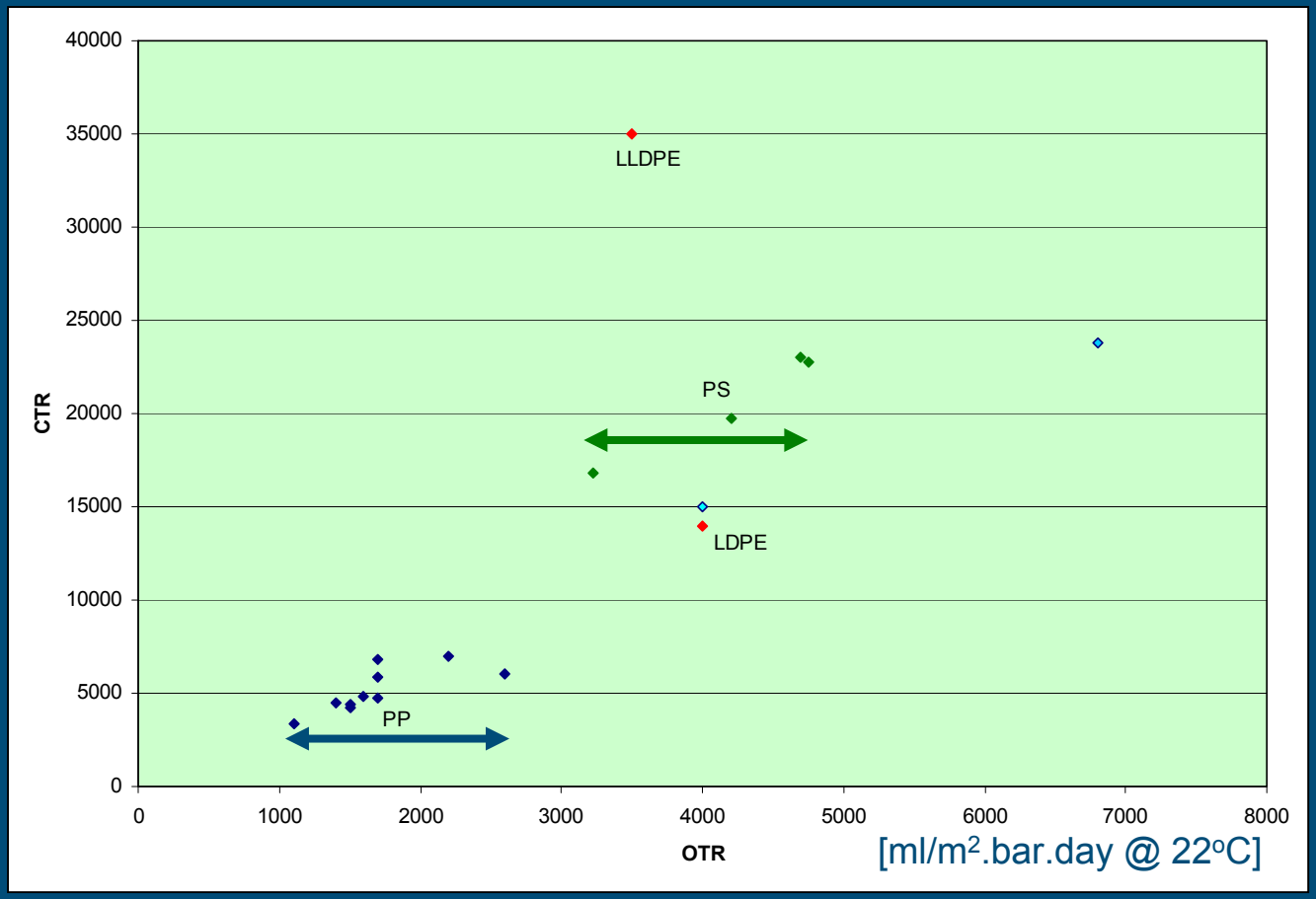




Commercially applied flow-pack films



Closer view


40000
35000
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10000
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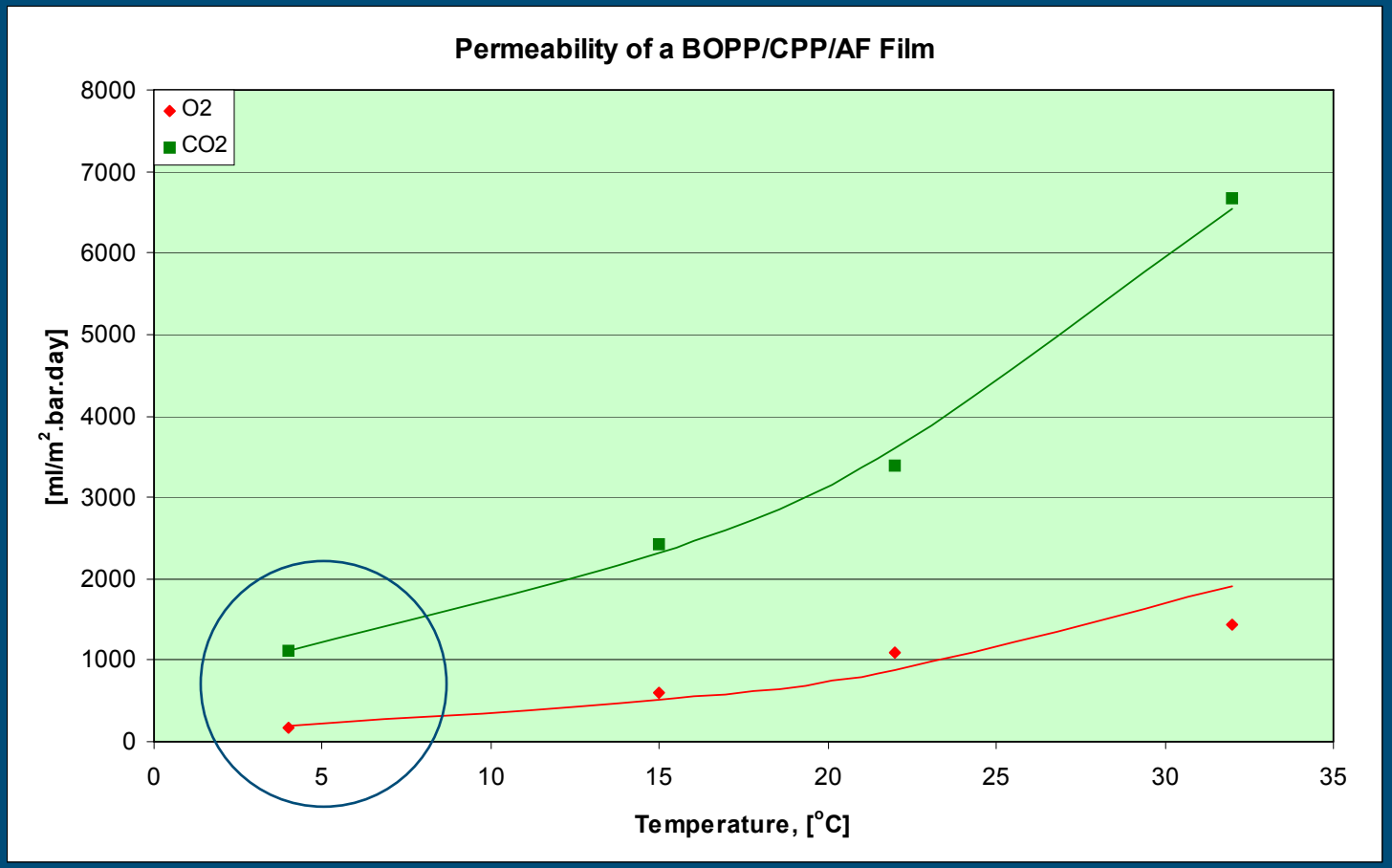
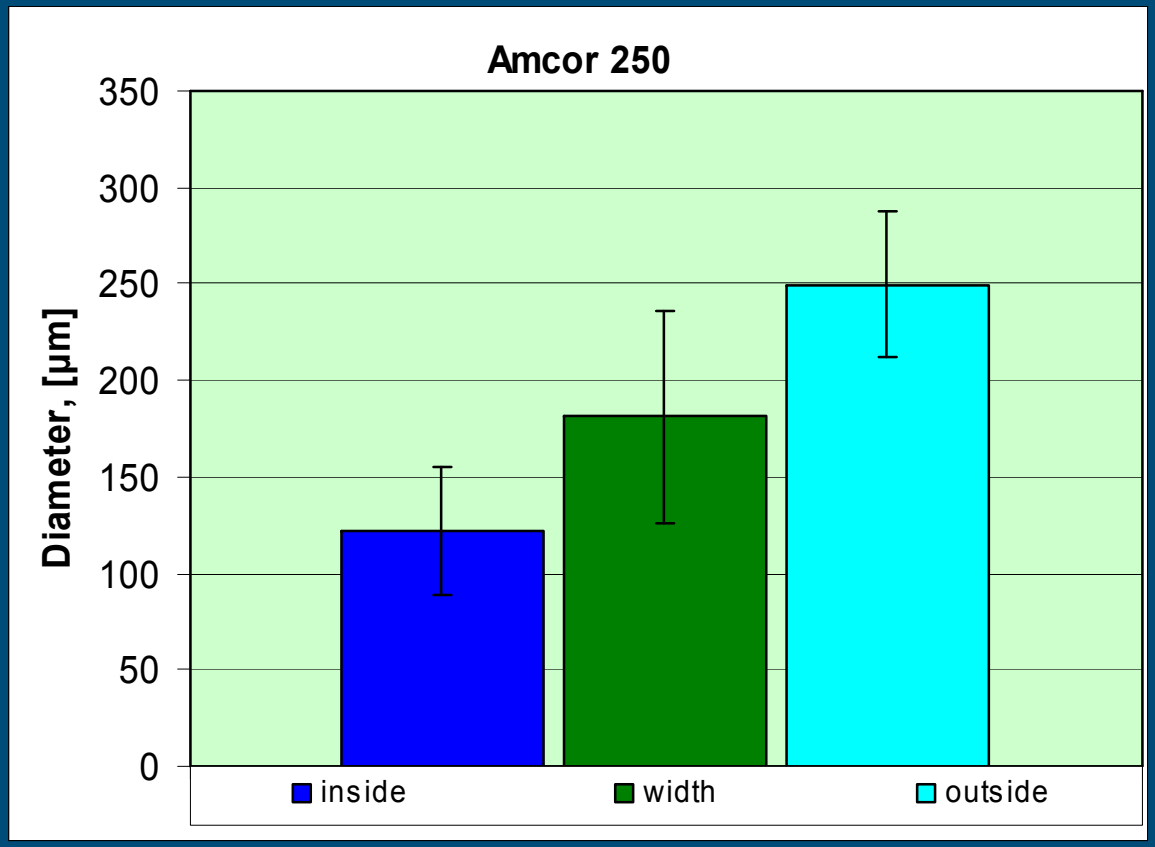
0
CTR
LLDPE
PS
LDPE
PP
0
1000
2000
3000
4000
5000
6000
7000
8000
OTR
[ml/m2.bar.day @ 22oC]

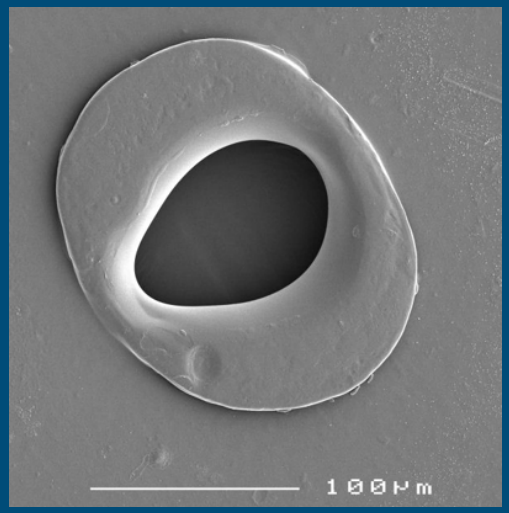
Temperature dependance

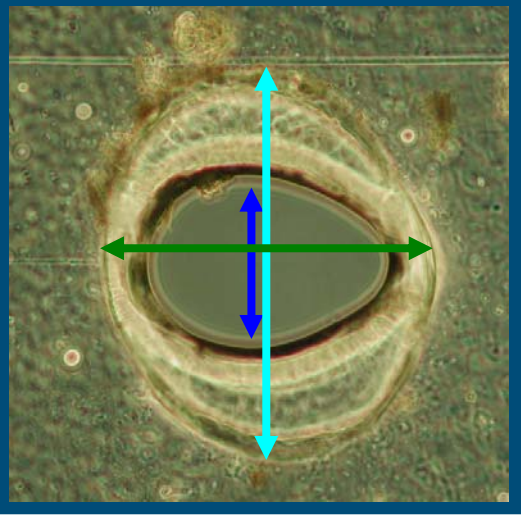


OTR, CTR and WVTR need to be specified at 7°C and 80-100%RH

Laser perforated films







3 Main protective packaging technologies

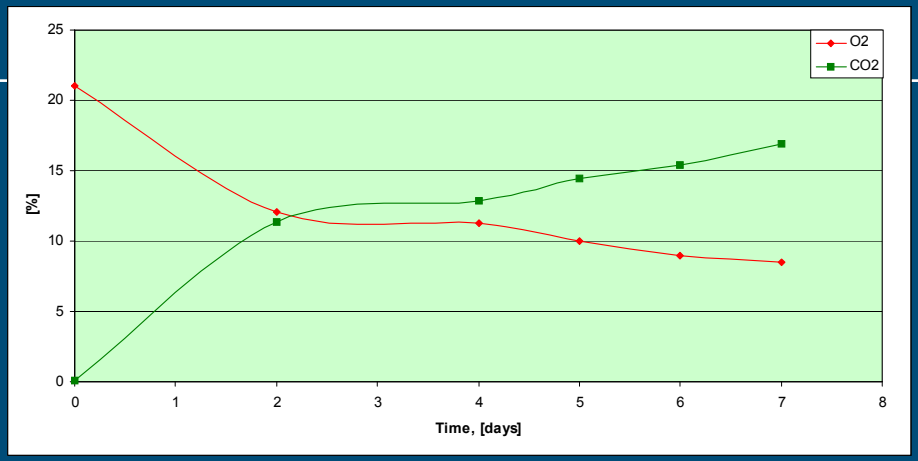
- **MHP**: Control of moisture loss [g/day]
  - Tomatoes, Bell-Pepper, Cucumber, Mushrooms...
  - Barrier film – Macro-perforated films
- **EMAP**: Control of gas composition [ml O_2/day, ml CO_2/day]
  - Strawberries, Spinach, Broccoli, Belgian Endive...
  - Laser perforated films
- **Anaerobic EMAP**
  - Additionally protective against cutting discoloration
  - Cut onions, Egg plant, courgette, salads, fruits…
  - Normal BOPP Film with at most 1 Micro perforation

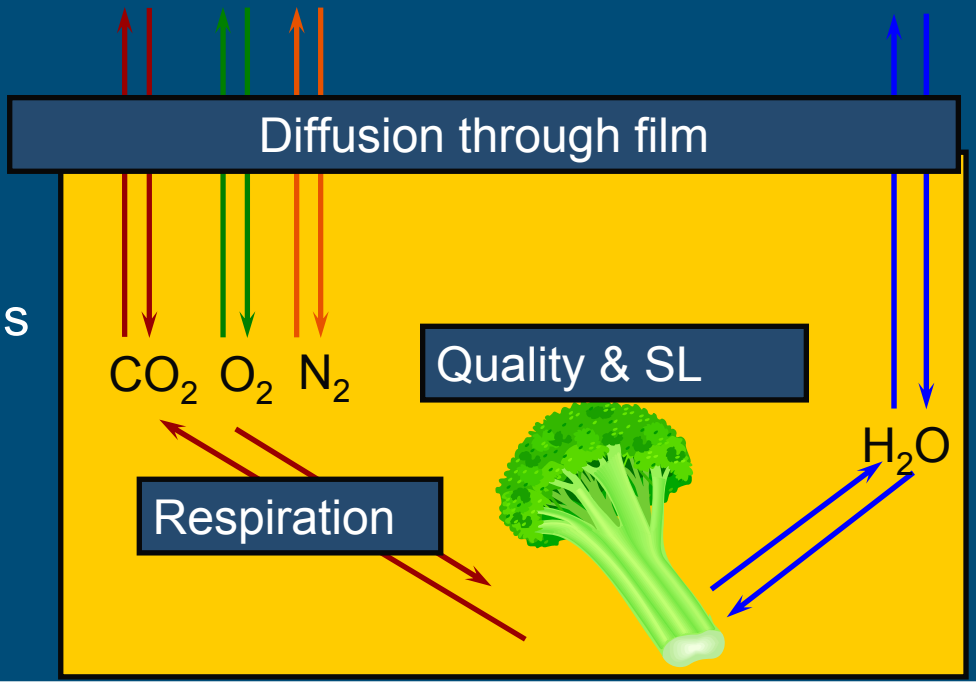
MHP

- Minimal water loss [0.01-0.05 g/d]
  - Cucumber
    - PE Shrink film
  - Corn salad, Rocket: high respiration
    - Micro-perforated PP flow packs with 20-40 holes
- Increased water loss to avoid fungal growth [0.05 – 0.2 g/d]:
  - Tomatoes, Bell-pepper, Flowers...
    - 5-10 mm Ø Holes in PP
- Highly increased water loss [>0.2 g/day]
  - Champignons, Soy bean sprouts…
    - PVC stretch film, OPS or PLA film or many big holes in PP film

E-MAP

- Every product has its ideal
  - Temperature
  - $[O_2]$ → OTR
  - $[CO_2]$ → CTR
  - RH% → WVTR
- Right film =
  - Correct permeability / number of micro-perforations
- Will prolong the shelf life
  - e.g. from 3 ->10 days





Successful E-MAP applications

- Strawberries – soft fruit
- Broccoli
- Chicory
- Stir fry mixes
- Soup vegetables
- ….

Strawberries in MAP

freshsafe

Freshsafe 1

Clam shell reference

Freshsafe 2

Shelf life

18°C 5 -> 7 days

12°C 6 -> 8 days

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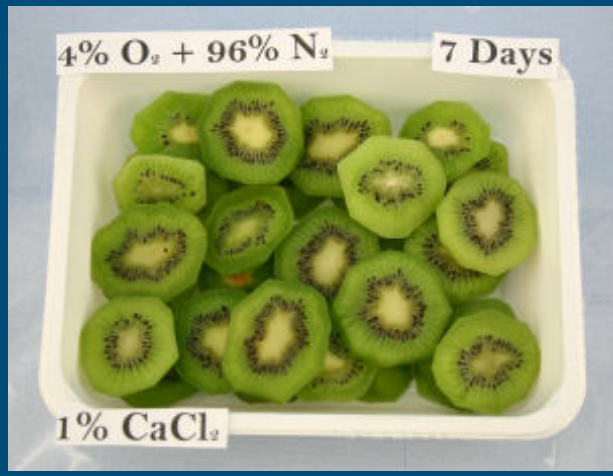
MULTIVAC
BETTER PACKAGING

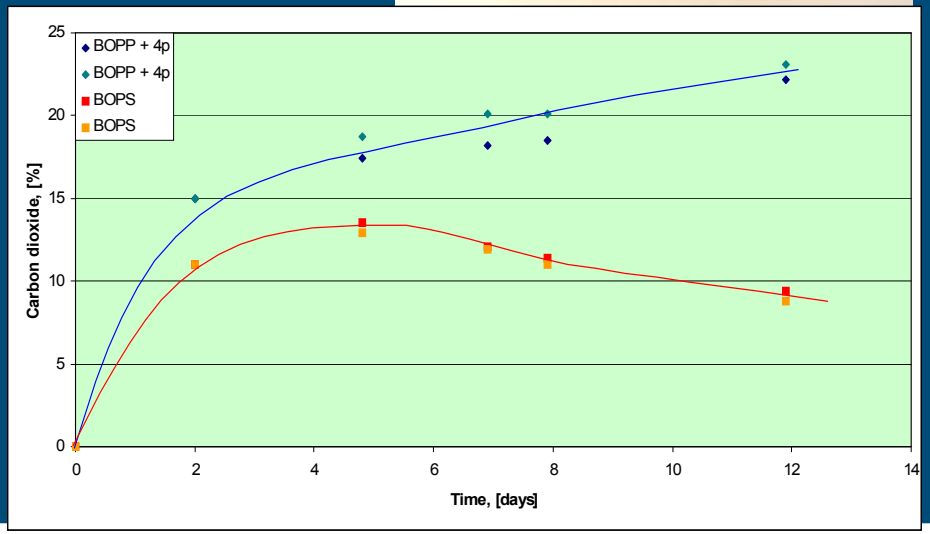
Cut fruit salads

- 12- 14 days of shelf life is possible for:
  - Cut apple, pear, pineapple, grape, banana…
  - In combination with
    - Right pre-treatment
    - Right initial gas mixture
    - Right package permeability
      - 2000-5000 ml O_2/kg.bar.day
      - 1500-10000 ml CO_2/kg.bar.day
- Hurdles for implementation
  - Mixed fruit salads: Melon?
  - Quality oriented purchase strategy
  - Decontamination of whole products



Stir fry mixes

- 5-10 Products in mix
- Optimal pre-treatments
  - Decontamination whole products
  - Cutting method
  - Washing method
  - Edible coatings (Ca^{2+}, vitamin C)
- Flow-packs with 2-6 Micro-perf.
  - Compromise atmosphere
  - 5-7 days of shelf life



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Anaerobic E-MAP

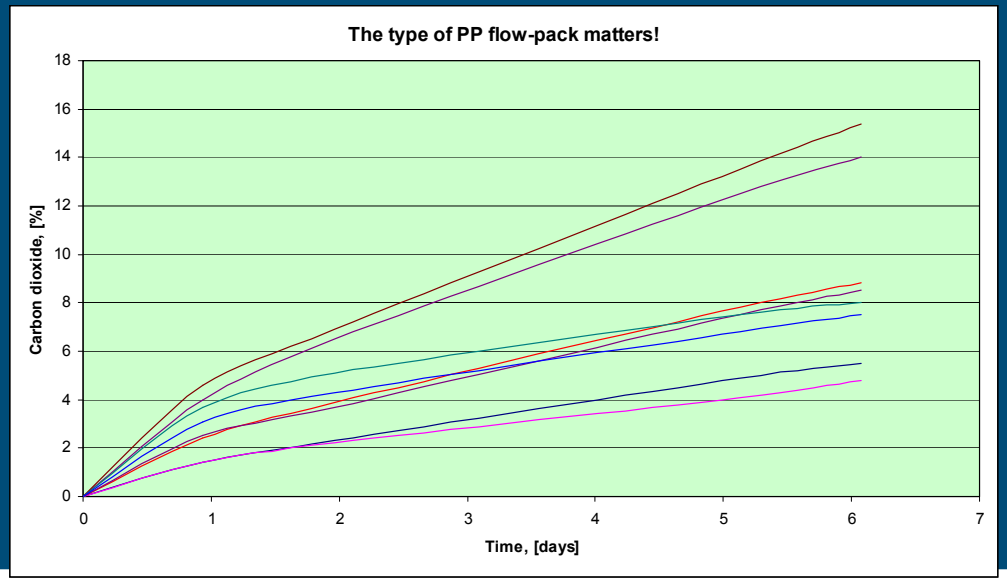
- Method to avoid discolorations / enzymatic browning

- Control the influx of O_2
  - Not too much → Discoloration
  - Not too little → Fermentation
- Control the outflux of CO_2
  - Avoid suffocation in high CO_2 atmospheres
  - Raise α (CO_2/O_2)

Mixed salads

- Respiration:
  - High: cut Belgian endive, Endive, Grated carrot
  - Middle: Iceberg, *Lolla Bionda*
  - Low: Butter head lettuce, Cabbage
- 0-1 micro-perforations in BOPP
- Initial oxygen concentration
- 5-7 days of shelf life

- Problems
  - Quality variations
  - Fermentation
  - Moisture build up



3 Steps towards a high quality fresh product

- 1 Temperature ↓
- 2 Control initial product quality
  - Quality oriented purchase policy
  - Decontaminate
- 3 Optimising packages

New films for fresh offerings

- AE-MAP + MH
  - WVTR ↑
  - For instance (PP->PS)

- More reliable AE-MAP films
  - 1-2 micro-perforations are not reliable
  - OTR + CTR ↑
    - 1500-2000 ml/m^2.bar.day @ 7^oC

- Special films for unmet needs
  - Mushrooms
  - Green beans
  - Sprouts…
- Smart combinations with coatings & marinades and decontamination
- Oxygen responsive films?

Balance cut fruit and vegetable products

Dutch situation	1985 –	2005
Turnover	<1	750 M€
Nett profit	<1	>300 M€
Pack. Use film	0	1700 ton BOPP-AF

Thank you!

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