Modified Atmosphere Packing (MAP) SEMINAR

Recent Issues and Development in Modified Atmosphere Packaging (MAP) Technology

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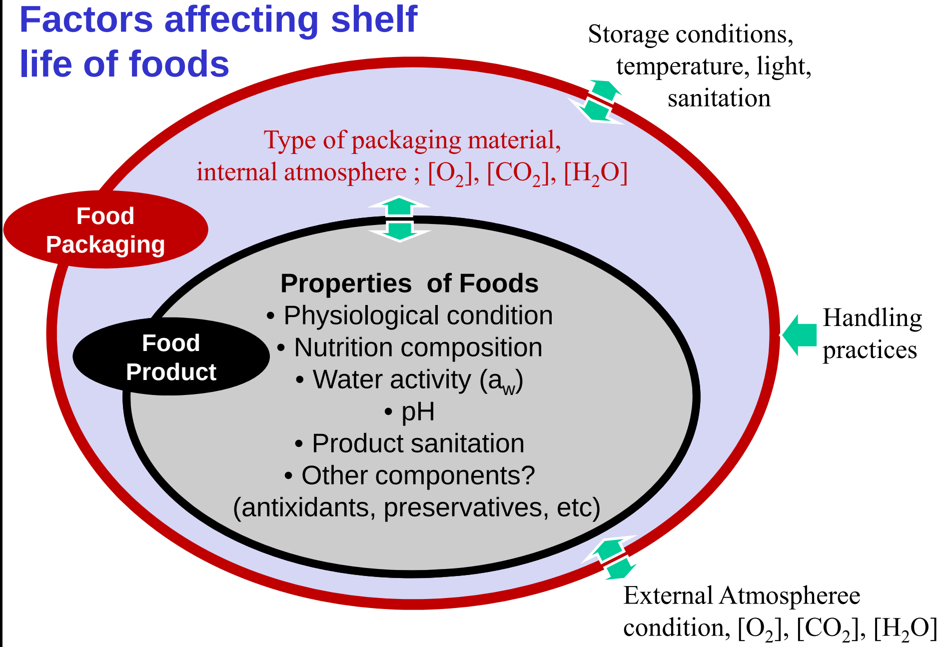
Factors affecting shelf life of foods



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Factors affecting shelf life of foods

Food Packaging

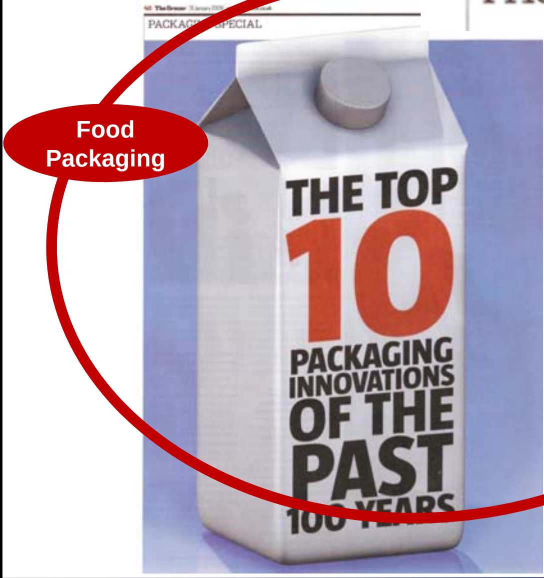
- In the food industry the role of packaging is significant in increasing a product's shelf life by
  - Ensuring food safety
  - Delaying food value degradation
- Shelf life is closely related to packaging.

Factors affecting shelf life of foods

Food Packaging

- In the food industry the role of packaging is significant in increasing a product's shelf life by "*regulating*" :
  - O_2 and CO_2
  - light
  - water vapour
  - aroma
  - mechanical impact.

Factors affecting shelf life of foods



Factors affecting shelf life of foods

PACKAGING SPECIAL

1. TIN CANS

Sometimes the simplest ideas are the best. The greatest packaging innovation of the past 100 years, as chosen by our experts, in theory shouldn't even qualify for the list. The tin can is actually nearer 200 years old and was first patented in 1810 by English inventor Peter Durand who learned how to dip metal plates into tin to protect them from rust before soldering them together. According to Bickerstaffe, however, the early "shell-case like" cans were very different to the lightweight ones we see today. "The cans were so heavy that they had to be taken home in a wheelbarrow, and you needed a toolkit to break into them." Cans only became mass market in the 1930s and have remained the most important food packaging format ever since. With the recession now focusing consumer minds on reducing food waste and buying cheaper food, cans can only go from strength to strength.

Factors affecting shelf life of foods

40 The Grocer 31 January 2009 www.thegrocer.co.uk

PACKAGING SPECIAL

Innovation will also be a major area of debate. What better time, then, to look at the greatest food and drink packaging innovations of the past 100 years.

The Grocer asked three champions of the packaging industry to choose 10 innovations that stand out from the crowd. The results might just change a few people's opinions:

1. Tin cans

The greatest innovation may be nearly two centuries old, but that doesn't stop it from being a very modern solution in a recession-ravaged environment (see above).

2. Aseptic cartons

Tetra Pak cartons have become so ubiquitous that there are not many drinks or liquid-based foods you can't buy in them these days. They're also a great example of an innovation driven by retail need (see p44).

3. Modified atmosphere packaging

As with food cans, the invention of modified atmosphere packaging was a major step forward in the battle against food waste, says Bickerstaffe. Indeed, when it was introduced on a mass scale about 20 years ago, in-store meat wastage was immediately reduced by a quarter.

Modified atmosphere packaging has played a major role in cutting down on food waste

"It changed beyond all recognition how fresh food is consumed. Thanks to modified packaging, broccoli, for example, which once only used to last for a couple of days, now has a shelf life of anything up to two weeks," she says. "It's also good news for the environment – where before fresh food had to be air-freighted, now it can be shipped."

As the name suggests, modified atmosphere packaging contains modified air – the nitrogen/carbon dioxide/oxygen ratio is tailored in a specific way to protect that particular food against rotting. If there is a tray element to the packaging, it will typically contain 'scavenger' chemicals to stop oxygen proliferation.

Film packaging on fruit and vegetables typically consists of several permeable layers to absorb the respiring products. With meat and fish, a 'barrier' film is used to prevent any exchange of gases. "You get some misguided people who think the

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Fruits and Nuts are Living

- **Consume**
  - O_2
  - Substrates
- **Evolve**
  - CO_2
  - Heat
  - Ethylene
  - Lose H_2O through epidermis
- **Metabolically active**
  - Tissue softening
  - Starch to sugars
  - Sorbitol to fructose
  - Organic acids decreasing
  - Flavor volatiles increasing
  - Color changes

Factors Affecting Storage Life of Fruit and Vegetables

Post Harvest Physiology

Pre-Harvest Conditions

•Top quality damage-free produce
•Minerals

Temperature

•Pre-cooling
•Correct storage temperature

Controlled Atmosphere

•Physiology
•Relative humidity Oxygen
•Carbon dioxide
•Ethylene
•Dealing

Factors Affecting Storage Life of Fruit and Vegetables

Post Harvest Physiology

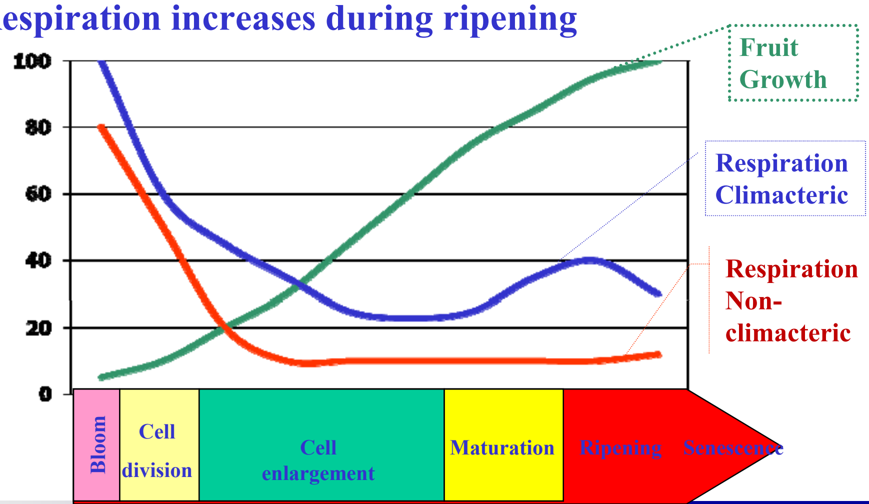
Types of Fruit

- **Climacteric**
  - Apples
  - Pears
  - Apricot
  - Peach
  - Plum
  - Fig
  - Persimmon
- **Non-climacteric**
  - Blueberries
  - Grapes
  - Cherries
  - Strawberries
  - Sweet oranges
  - Lemons

Factors Affecting Storage Life of Fruit and Vegetables

Post Harvest Physiology

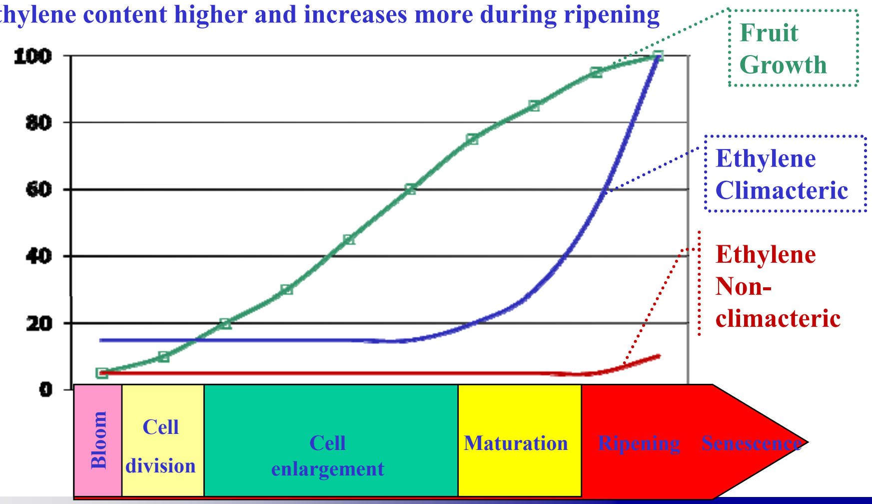
- Respiration increases during ripening



Factors Affecting Storage Life of Fruit and Vegetables

Post Harvest Physiology

- Ethylene content higher and increases more during ripening



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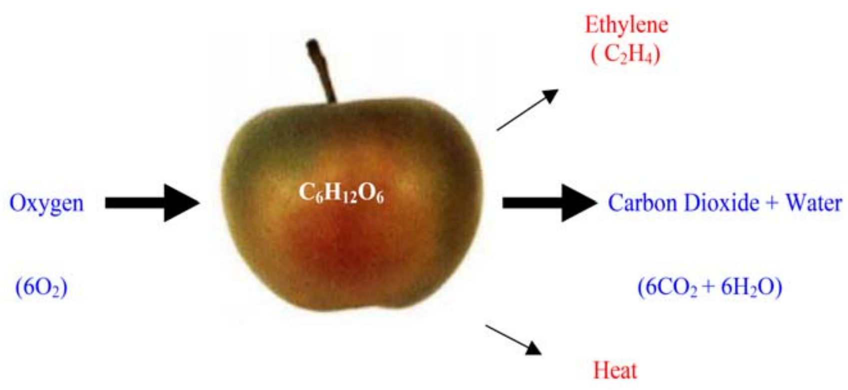
Factors Affecting Storage Life of Fruit and Vegetables



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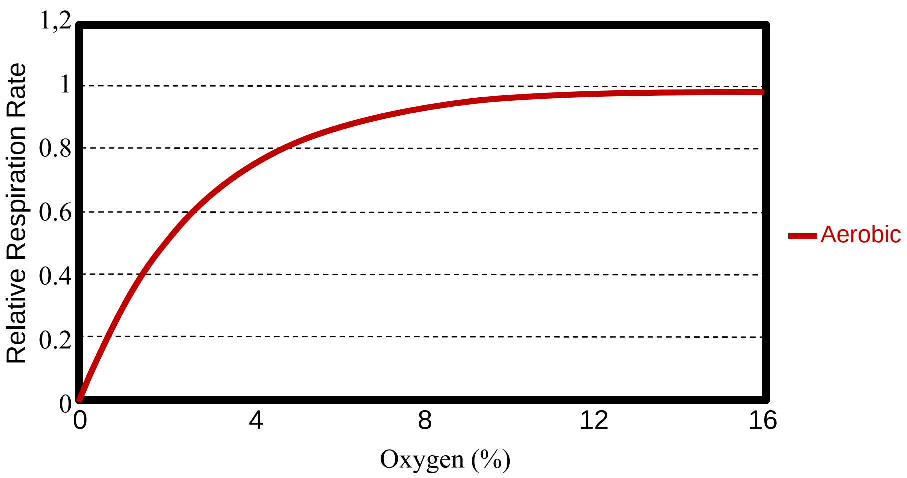
Factors Affecting Storage Life of Fruit and Vegetables

Oxygen Concentration vs Respiration



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Factors Affecting Storage Life of Fruit and Vegetables

Oxygen Concentration vs Respiration

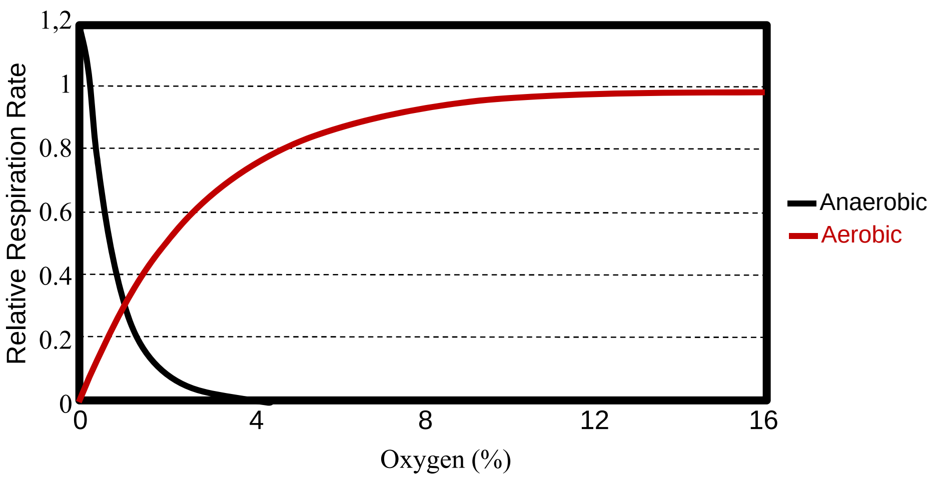
At low $[O_2]$

Fermenting carbohydrates in fruits or grains anaerobically, produce ethyl alcohol

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

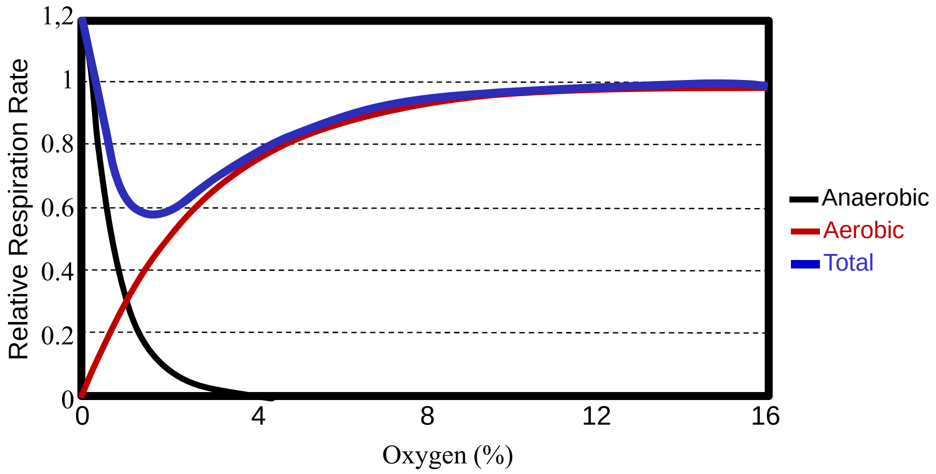
Factors Affecting Storage Life of Fruit and Vegetables

Oxygen Concentration vs Respiration



Factors Affecting Storage Life of Fruit and Vegetables

Oxygen Concentration vs Respiration



Factors Affecting Storage Life of Fruit and Vegetables

CO_2 Concentration?

Raising the level of carbon dioxide to levels of 2 % or more can also be beneficial

- reduce the products sensitivity to ethylene
- slow the loss of chlorophyll which is the green colour of fruit and vegetables
- High CO_2 can also slow the growth of many of the postharvest fungi that cause rots.

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Methods of Storage

Storage of Apples

- ***Oxygen Level***
- **Lower to 3% from 21%**
  - **Reduce respiration**
  - **Reduce ethylene production**
- **If too low**
  - **Anaerobic metabolism**
  - **Off flavors**

- ***Carbon dioxide Level***
- ***Increase to 5% from 0.03%***
  - ***Reduce respiration***
  - ***Reduce ethylene production***
  - ***Inhibit the breakdown of pectic substances***
- ***If too high***
  - ***Anaerobic metabolism***
  - ***Off flavors***

Some examples of products that benefit from Controlled Atmosphere or Modified Atmosphere storage*.

Product	Temperature °C	Oxygen (%)	CO_2 (%)	Storage life in air (days)	Storage life in CA /MAP (days)
Apple, Gala	0 - 2	1.5 – 2.5	1 - 5	120	180
Avocado	5 - 13	2 - 5	3 - 10	42	84
Banana	13 - 16	2 - 5	2 - 5	28	49
Bean, snap	4 - 8	2 - 3	4 - 7	7	14
Broccoli	0 - 1	1 - 3	5 - 15	28	56
Lettuce	0 - 1	2 - 5	< 1%	21	28
Pear	- 1 - 1	2 - 3	0 - 1	90	180
Pepper, Bell	7 - 12	2 - 5	2 - 5	21	28
Strawberry	- 0.5 - 0	5 - 10	15 - 20	14	21

*From (i) Transicold (1995). Controlled Atmosphere Handbook and (ii) Optimal Fresh (2000). CSIRO Publishing.

- ***Fresh Cut/Minimally Processed?***

- ***Fresh Cut/Minimally Processed?***

MAP for Fresh Cut

Low O_2 and/or elevated CO_2environment within a fresh-cut MAP extend fresh-cut product shelf-life by:

- slowing browning reactions
- reducing the rate of product respiration and
- reducing C_2H_4 biosynthesis and action
- Elevated CO2 environments within MAP bring an additional benefit of being fungistatic → are commercially used in both the whole and fresh-cut strawberry industry to reduce the growth of *Botrytis cinerea.*

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FISH product and MAP

Lower O_2:

- ✓ Reduced oxidation
- ✓ Reduced microbial activity

Higher CO_2

- ✓ Antimicrobial effect – Gram-negative organisms with aerobic metabolisms

FISH product and MAP

Comparison of MAP, air and vacuum packaging:

Shelf life (sensory evaluation)

Sivertsvik, M., Jeksrud, W.K., Rosnes, T., International Journal of Food Science and Technology 2002, 37, 107±127

	MAP	Air	Vacuum	**Storage temp**	**$CO_2/N_2/O_2$**
Cod (G. morhua) fillets	**17**	**6**	**16**	8	0/100/0
Catfish (filets)	**13**	**6**	**6**	8	75/25/0
Salmon (S.salar	**17**	**11**	**17**	2	60/40/0
Shrimp, spotted (Pandalus platyceros)	**14**	**7**		0	100/0/0
Swordfish (Xiphias gladius) steaks	**22**	**6**		2	100/0/0

MEAT & Poultry product and MAP

Modified Atmospheres Used in Fresh Meat in USA

- 80% oxygen + 20% carbon dioxide
- 0.4% carbon monoxide + 60% carbon dioxide + 39.6% nitrogen (approved for bulk packages during transport, February, 2002, and for retail packages in January, 2004.

MEAT & Poultry product and MAP

Pros/Cons of 80% oxygen MAP

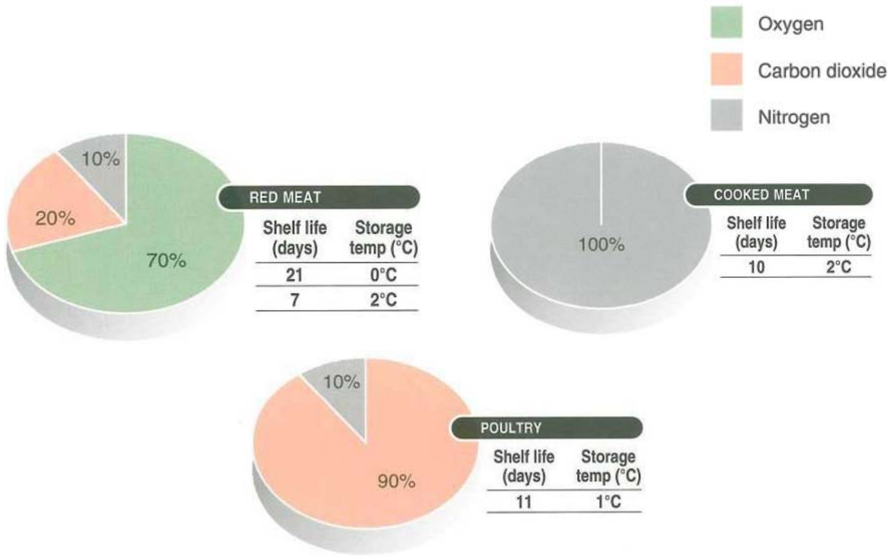
- Advantages
  - 10-14 day redness, vs 3-5 days in PVC
- Disadvantages
  - Premature Browning during cooking
  - Oxidized (rancid) flavor
  - Bone darkening

MEAT & Poultry product and MAP

Pros/Cons of 0.4% CO-MAP

- Advantages
  - 28 days redness of ground beef, 35 days for steaks or roasts.
  - No oxidized flavor, no bone darkening
- Disadvantages
  - CO safety concerns
  - Can spoiled meat appear fresh?
  - Persistent pinking after cooking?

MEAT & Poultry product and MAP



ROP Pathogens of Concern

- ***Clostridium botulinum*** – spore former, obligate anaerobe, is a concern with ROP foods.
  - **Minimal growth requirement for *C. botulinum***

Property	Group I Proteolytic Type A, B, F	Group II Non-Proteolytic Type B, F, E
Inhibitory pH	**4.6**	**5.0**
Inhibitory NaCl	**10%**	**5%**
Minimum a_w	**0.94**	**0.97**
Temp. optimum	**98° F**	**86° F**
Temp. range	**50 -118° F**	**38 -113° F**
Toxin production	**≥ 50° F**	**≥ 38° F**

ROP Pathogens of Concern

- ***Listeria monocytogenes***
- Conditions for LM growth:
  - ≤ 10 % salt
  - 5-10 % O_2
  - pH 4.1 – 9.6
  - a_w 0.90 - 0.93
  - 28° F - 122° F
  - LM can survive months in a moist environment - steam from cooking, dishwashing machines, pressure sprayers.
  - LM competes well with other organisms, especially at refrigeration temperatures
  - LM is more heat resistant than most vegetative pathogens – a concern with lightly cooked foods

Terimakasih

- **Product**
  - Raw material
  - Process
  - Hygiene.

- **Packaging-material and -machine**
  - Barrier
  - Runability
  - Sealability
  - Design
  - Hygiene.

Packaged product

- **Distribution:**
  - Time
  - Temperature
  - Light
  - Mechanical impact
  - Logistics
  - Environment
  - Consumer.