L’EMBALLAGE ALIMENTAIRE EN 1H30



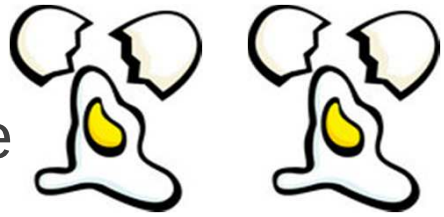
+ Conserver & Protéger
+ Garantir la Sécurité
+ Communiquer & Inform
+ Traçabilité
+ Stocker, Transporter & Distribuer

✓ mécaniques
✓ Lumière
✓ Contaminations micro-biologiques
✓ Contaminations

L'EMBALLAGE: UN ÉLÉMENT ESSENTIEL

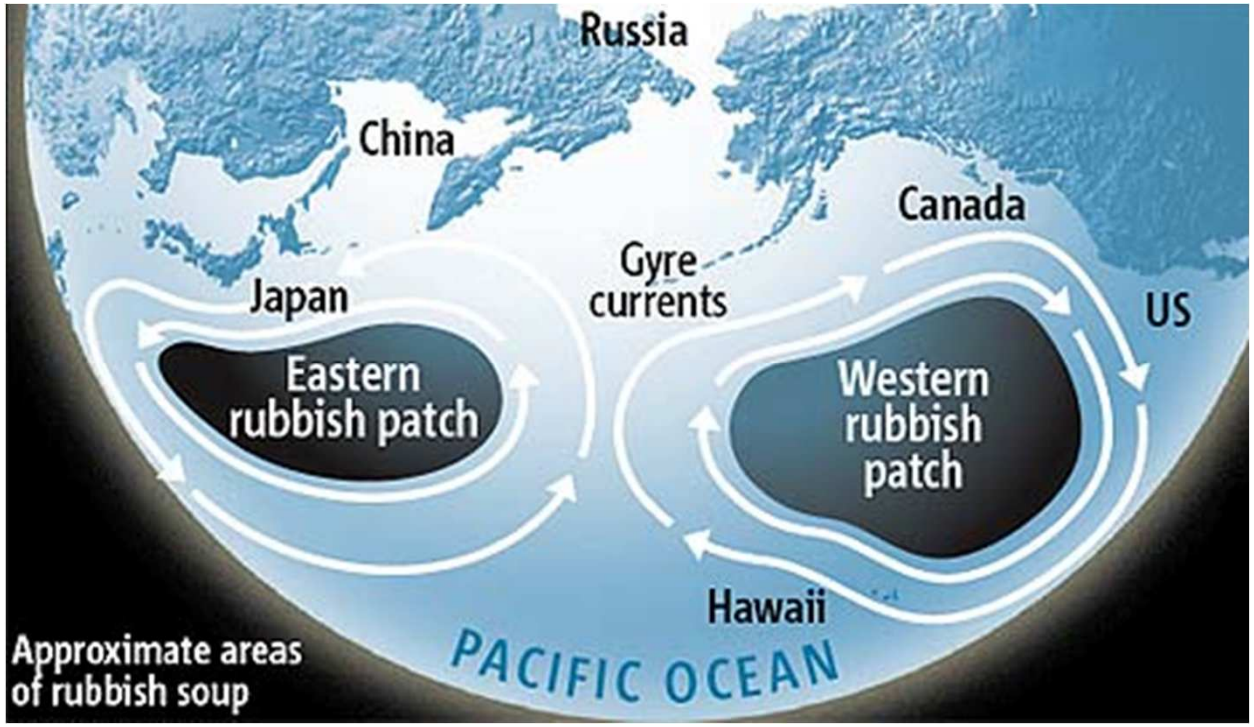
SANTÉ SÉCURITÉ

Réduction des risques de contaminations et d'intoxications alimentaires



DURABILITÉ

Réduction des pertes et gaspillages alimentaires (plus d'un tiers de la production)



L’EMBALLAGE: DES RISQUES À MAITRISER

SANTÉ SÉCURITÉ
Contamination chimique de l’aliment par migration

DURABILITÉ
Gestion des déchets d’emballages, impact sur l’environnement

Emballages innovants et qualité des aliments: emballages actifs et intelligents

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Professeur Université Montpellier
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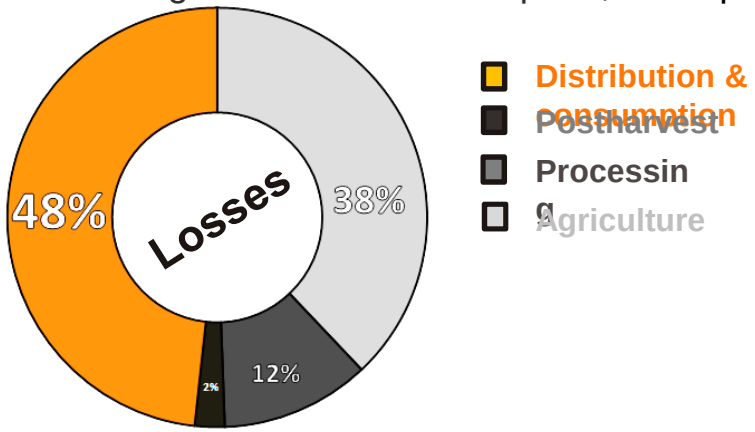
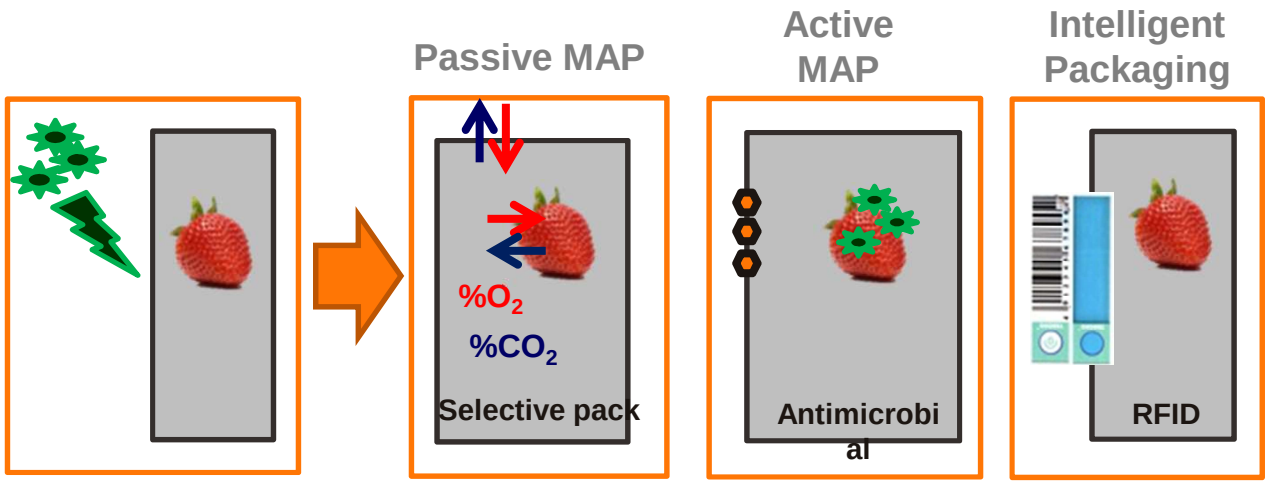
Sustainable packaging to reduce fresh food losses and wastes

- More than half of the fresh fruit and vegetable production is lost before consumption
- Most of the losses during distribution/consumption, when packaging is involved



Repartition of the losses through the supply chain for fruits and vegetables in 2007 (adapted from Gustavsson et al. 2011)



Définitions

Règlement de la commission Européenne (EC) No 450/2009

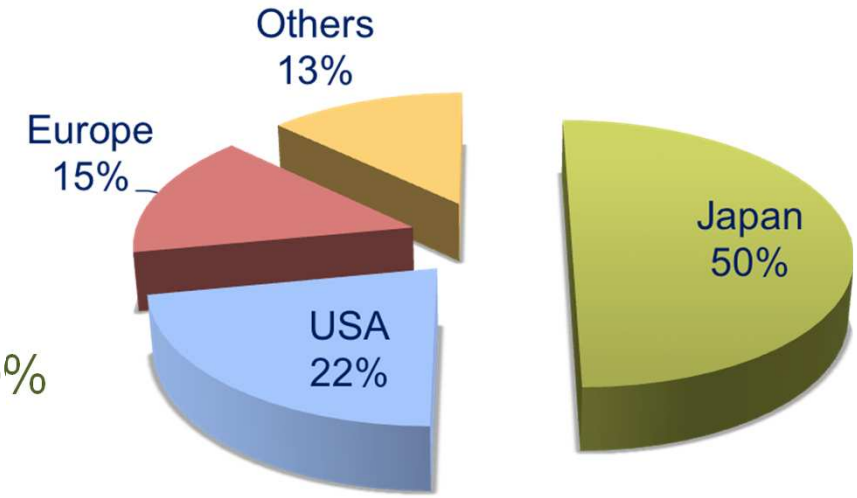
Art. 3(a) Emballages actifs: absorbent ou émettent volontairement une ou plusieurs substances dans l'objectif de préserver les qualités du produit alimentaire

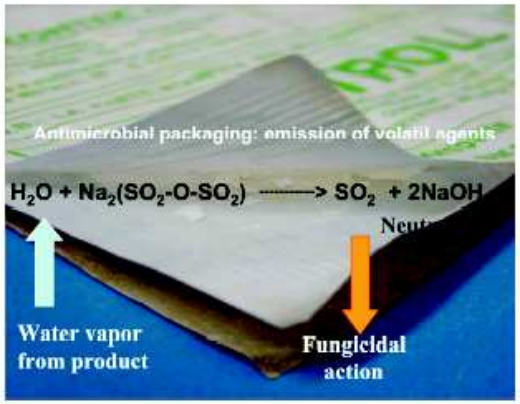
Art. 3(b) Emballages intelligents: permettent de suivre l'évolution de la qualité ou des conditions externes de conservation influençant la qualité des produits alimentaires

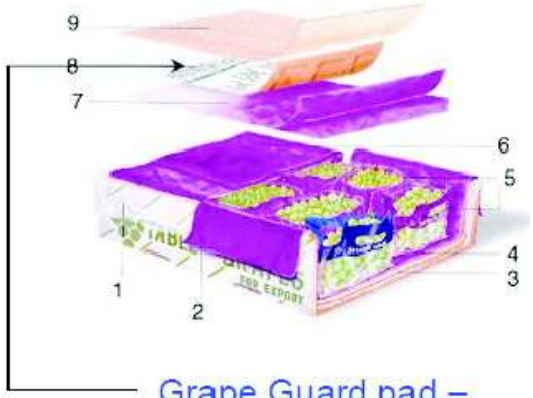
Taux annuel de croissance en Europe:

Emballages conventionnels: 4.2%

Emballages actifs &intelligents > 10%







Grape Guard pad – SO_2 release

SO_2 emitter

CO_2 absorber/emitters

Ethanol releaser

Silver based antimicrobial packaging

Ethylen absorber

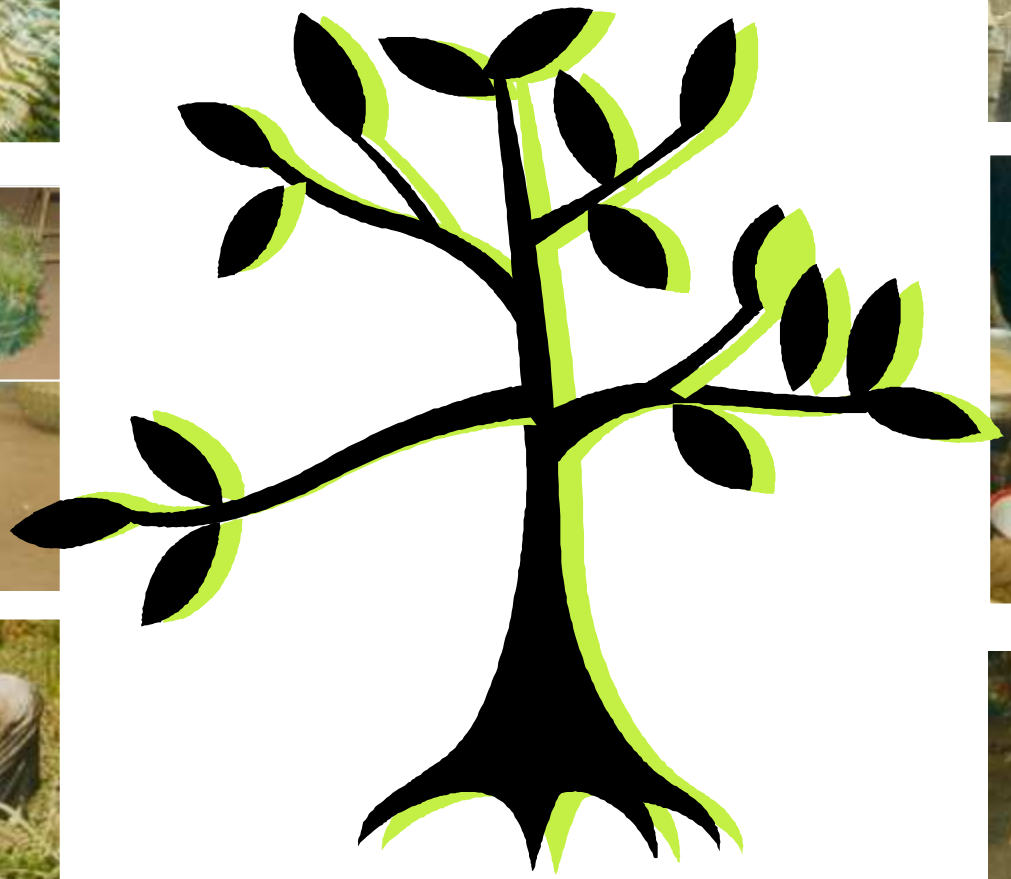
Moisture absorber

Self-cooling or self-heating packaging

Oxygen absorber

Cryovac OS 1000 multilayered film

THE ROOTS OF ACTIVE & INTELLIGENT FOOD PACKAGING



The roots: traditional vegetal leaves in tropical area of Africa, Asia and South America

Active Packaging fight food degradations

Oxydation of coumpounds of interest:

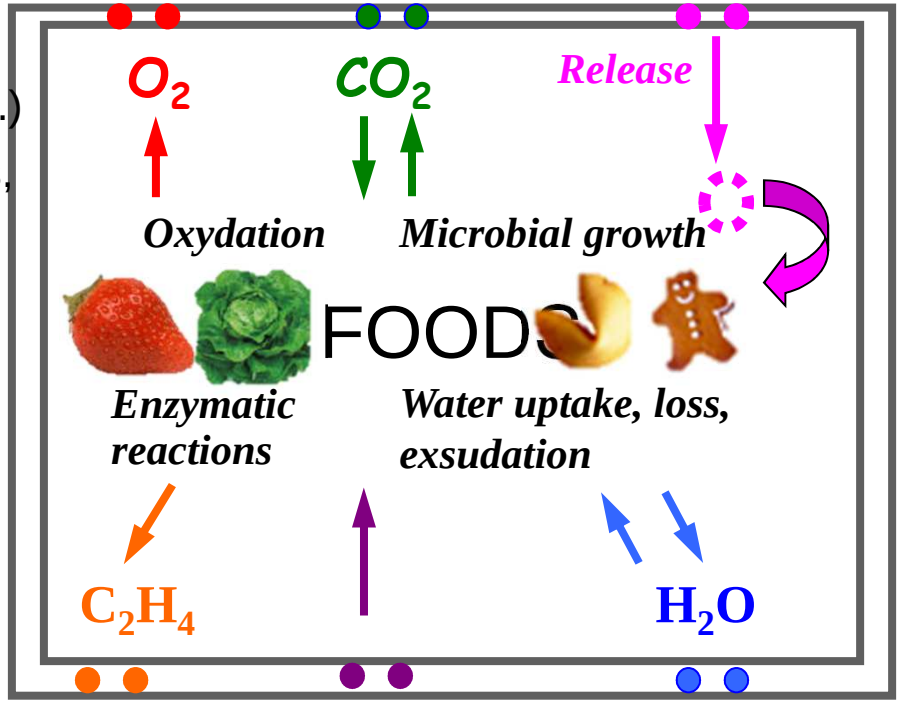
•Organoleptic (aroma compounds, pigments..)

•Nutritionnals (vitamins, essential fatty acids…)

Respiration, maturation of living products:

•Fruits and vegetables

•Sea foods….



Microbial growth:

•spoilage

•pathogens

• surface contamination

Liquid (exsudat) or vapor (a_W):

•Texture de degradation

•Increase others degradations mecanisms, especially microbial growth

Addition of fragile additives:

• vitamins,

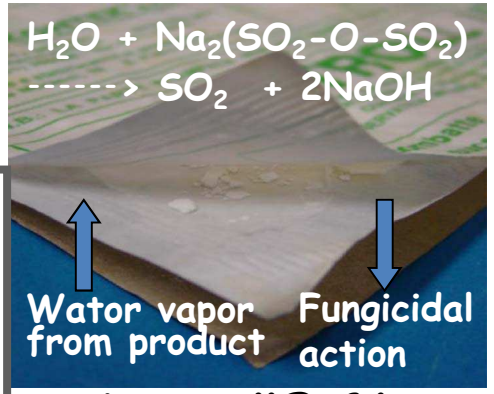
• pre/probiotics

•Aroma compounds …

Active Packaging for fresh fruits and vegetable

Lightly processed fruits & vegetables

Azote flux + barrier film



Kontroll® film

Kontek

Antimicrobial (moulds)

O_2 CO_2 *Release*

Respiration *Micro-organisms*

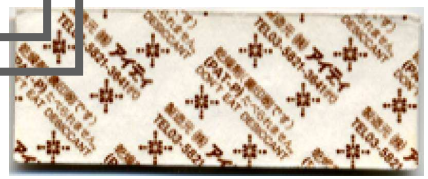
FOODS

Maturation *Transpiration*

Ethylen scavenger

Trimbach verpakking

C_2H_4 H_2O



Moisture absorber

Oxygen absorbers

☞ Iron oxydation:

$Fe + O_2 + H_2O$ ----> $Fe(OH)_3$

Paper based gaz permeable sachet

1 g of Fe absorb:

0,134 mol d'O_2, 325 ml d'O_2 à 25° C

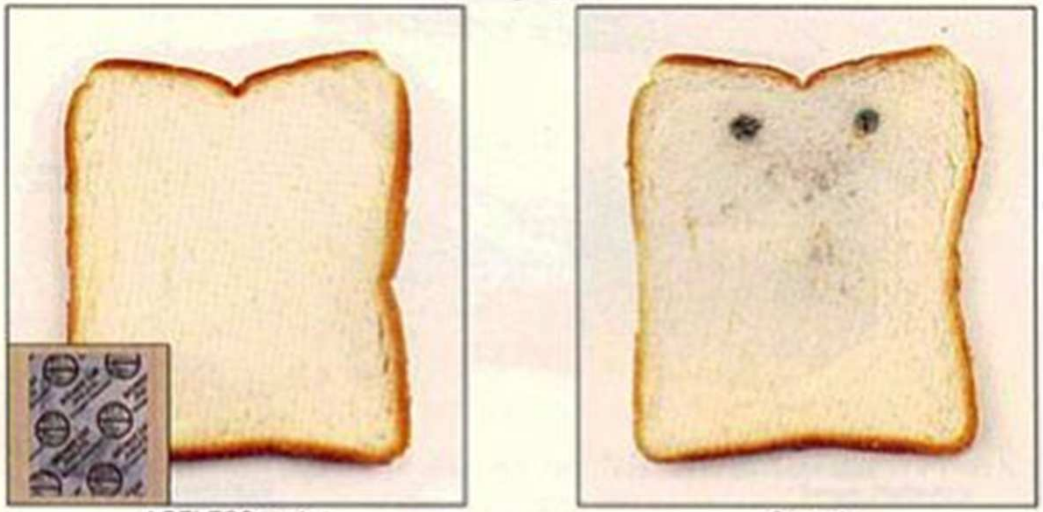
☞ Ascorbic acid, catechol oxydation

☞ Enzymatic catalysis (glucose oxydase/catalase system)

☞ Others reactions

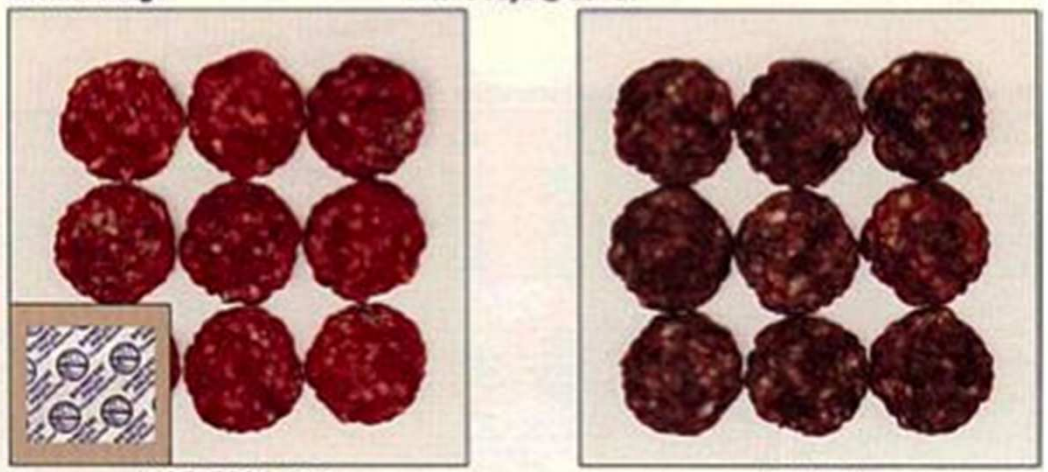

AGELESS®
DO NOT CONSUME
OXYGEN ABSORBER
THIS LABEL HELPS TO
MAINTAIN THE QUALITY
AND FRESHNESS OF
THE FOOD.
AGELESS®
DO NOT CONSUME
OXYGEN ABSORBER

Bread — After 20 days @ 25° C.



AGELESS packet — Control

Hard Sausage — After 5 days @ 25° C.



AGELESS packet — Control

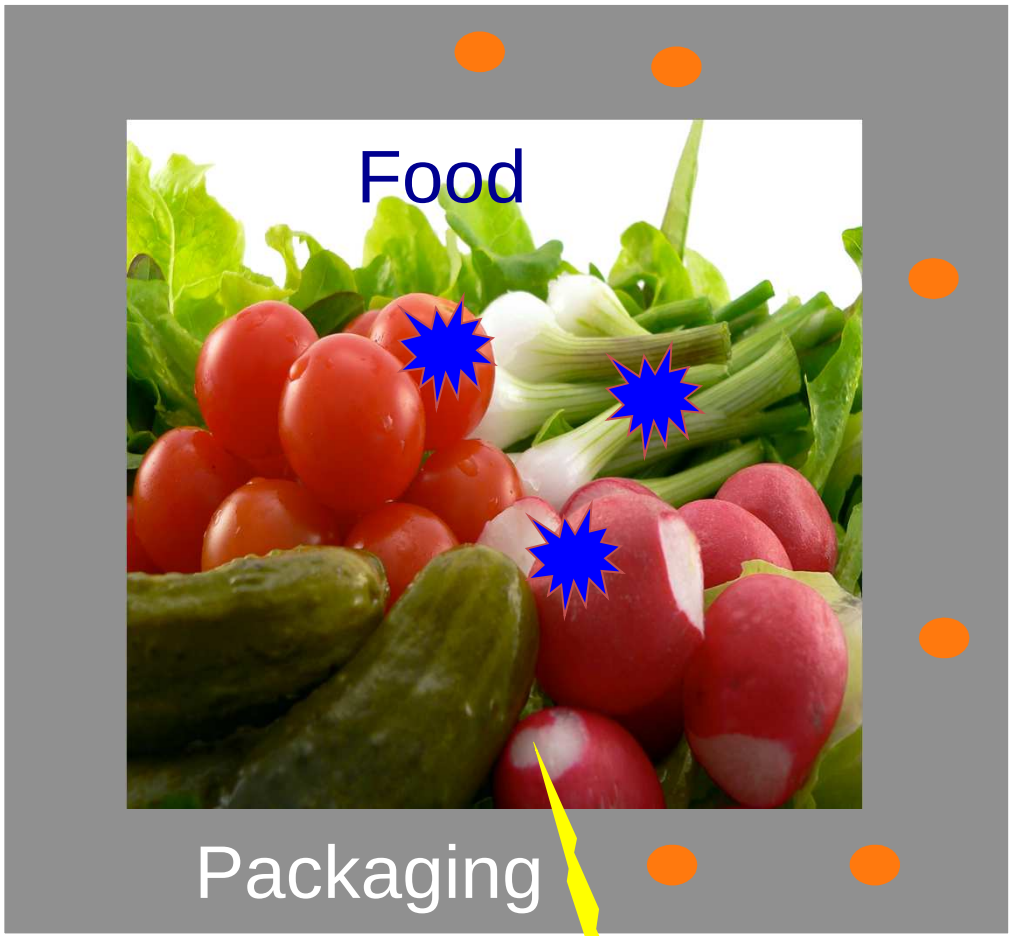
OVERVIEW OF COMMERCIAL OXYGEN SCAVENGERS

Table 1—Overview of commercial oxygen scavengers

Format	Trade Name	Manufacturer	References
Card	Ageless®	Mitsubishi Gas Chemical Co. (Japan)	
Closure Liner	Darex®	Grace Performance Chemicals (U.S.A.)	Teumac (1995), Brody and others (2001)
	PureSeal®	Advanced Oxygen Technologies Inc. (U.S.A.)	Teumac (1995)
	Smartcap®	Advanced Oxygen Technologies Inc. (U.S.A.)	Teumac (1995)
Concentrate	Amosorb®, 2000, 3000	BP Amoco Chemical (U.S.A.)	
	Oxbar™	Crown Cork and Seal (U.S.A.)	Brody and others (2001)
	Oxyguard™	Toyo Seikan Kaisha (Japan)	
	Oxysorb®	Pillsbery Co (U.S.A.)	
Film	Bioka®	Bioka Ltd (Finland)	
	OS2000®	Sealed Air Corporation (U.S.A.)	Butler (2002)
	ZERO2™	CSIRO and VisyPak (Australia)	Brody and others (2001)
Label	Ageless®	Mitsubishi Gas Chemical Co. (Japan)	
	ATCO®	Standa Industrie (France)	
	FreshMax®	Multisorb Technologies Inc. (U.S.A.)	
Sachet	Ageless®	Mitsubishi Gas Chemical Co. (Japan)	Nakamura and Hoshino (1983), Smith and others (1995), Lyver and others (1998)
	ATCO®	Standa Industrie (France)	Hurme and Ahvenainen (1996)
	Bioka®	Bioka Ltd (Finland)	Ahvenainen and Hurme (1997)
	Freshilizer®	Toppan Printing Co. (Japan)	Smith and others (1995)
	FreshPax®	Multisorb Technologies Inc (U.S.A.)	Smith and others (1995)
	Keplon™	Keplon Co. (Japan)	Brody and others (2001)
	Modulan™	Nippon Kayaku Co. (Japan)	Brody and others (2001)
	Negamold®[1]	Freund Industrial Co. (Japan)	Smith and others (1995)
	Oxyeater™	Ueno Seiyaku Co. (Japan)	Brody and others (2001)
	Oxysorb®	Pillsbury Co. (U.S.A.)	
	Sanso-cut®	Finetech Co. (Japan)	Hurme and Ahvenainen (1996)
	Sansoless™	Hakuyo Co. (Japan)	Brody and others (2001)
	Secule®	Nippon Soda Co. (Japan)	Brody and others (2001)
	Sequl®	Dai Nippon Co. (Japan)	Brody and others (2001)
	Tamotsu™	Oji Kako Co. (Japan)	Brody and others (2001)
	Vitalon®[2]	Toagosei Chemical Co. (Japan)	Hurme and Ahvenainen (1996)
Thermoformed Tray	Oxycap®	Standa Industrie (France)	

[1]Combined actions between O_2 scavenging and ethanol generation
[2]Combined actions between O_2 scavenging and CO_2 generation

Transfert dans les systemes aliment/emballage



Migrants:

Constituents de l'emballage

Gaz et vapeurs de l'environnement

Réactions de dégradation physico-chimiques et biologiques

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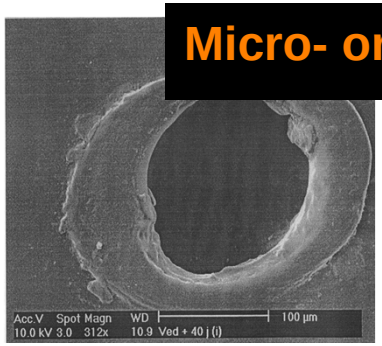
Plastic limitations for fresh fruits & vegetables preservation

Too low O_2 permeability
➔ **Anoxia**

Too low water vapor permeability
➔ **Condensation that favors development of micro-organisms**

Micro- or macro-perforated plastics



Insufficient permselectivity ratio (P_{CO_2}/P_{O_2})
➔ **Not adapted to CO_2-sensitive fresh produces**

Designing materials for fresh fruits & vegetables MAP

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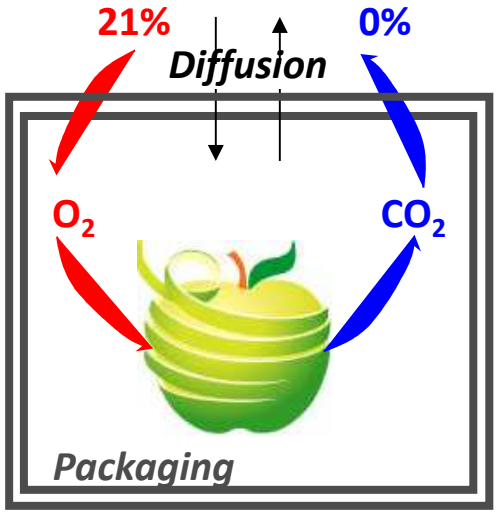
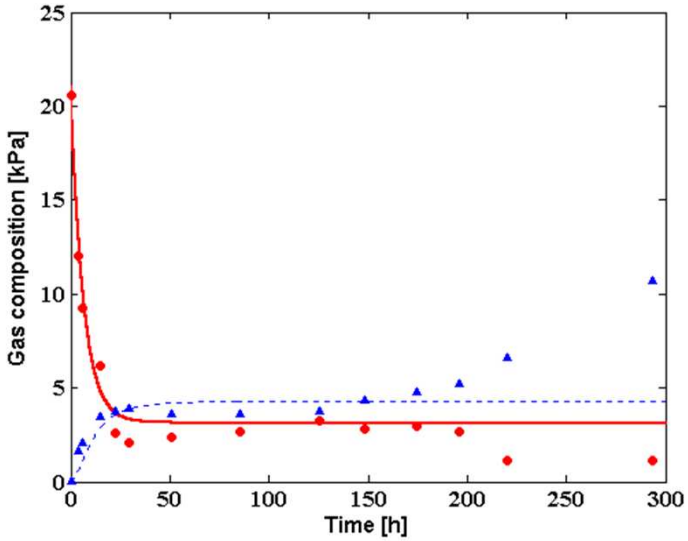
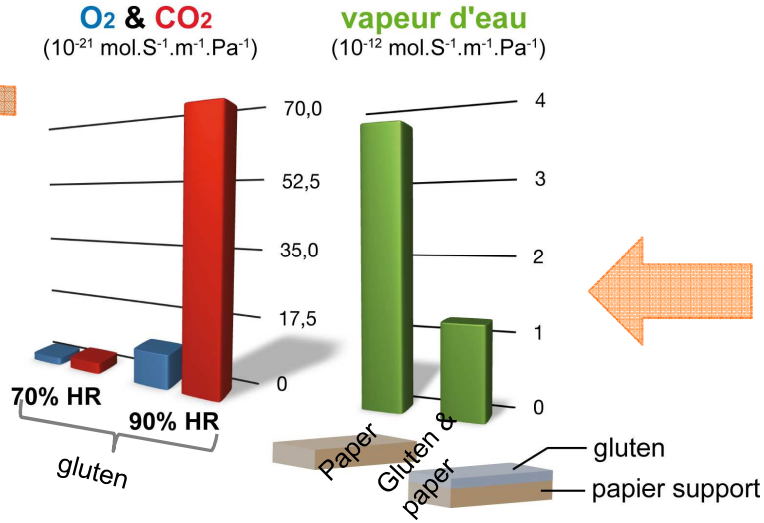
MAP modeling



$$(O_2)_t = \frac{Pe_{O2} * \Delta P * S * dt}{e} - \frac{RR_{O2}max * O_2 * m * dt}{(Km_{O2} + O_2) * (1 + CO_2 / Ki_{CO2})}$$



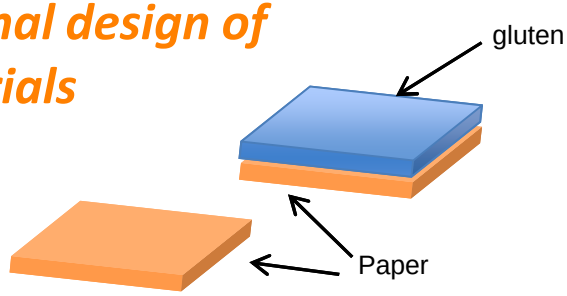


Rational design of materials

O_2 & CO_2 Perm, selectivity

Water vapor Perm

C_2H_4Perm/abs



Designing materials for fresh fruits & vegetables MAP

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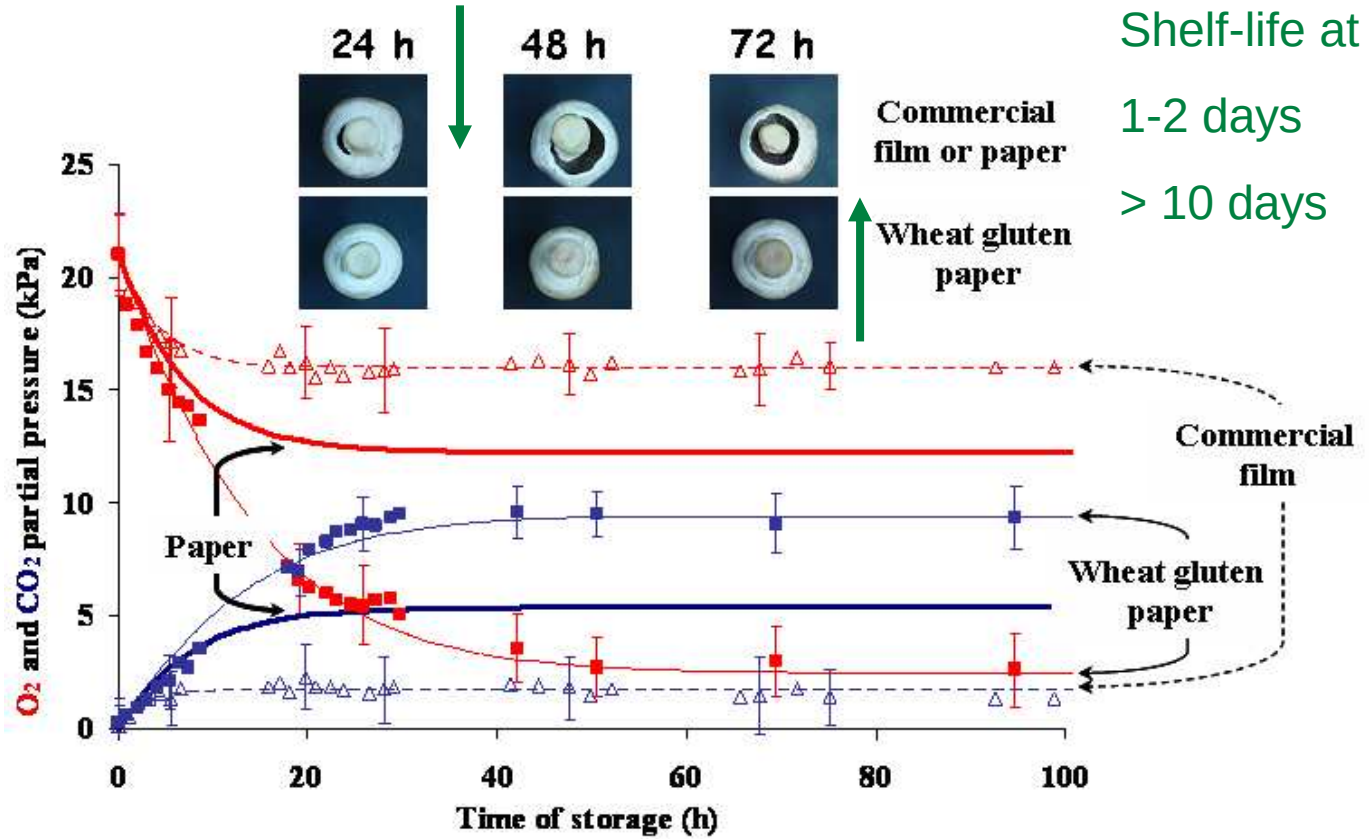
Cap opening and browning of mushrooms as a function of packaging



Shelf-life at 20° C

1-2 days

> 10 days

Coated paper increase shelf-life by →

- Delaying cap opening & browning
- maintaining good texture
- reducing microbial growth

Designing materials for fresh fruits & vegetables MAP

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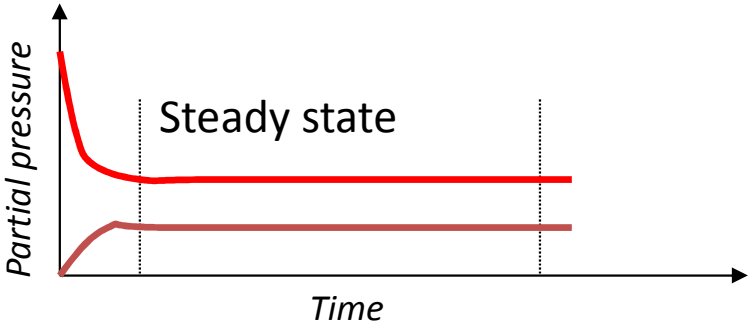
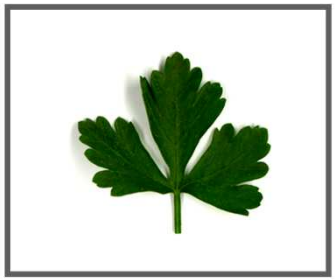


Papers	Control	Composite Nanocomposite
O_2 s.s. (kPa)	19 ± 1	11 ± 2
CO_2 s.s. (kPa)	0.5 ± 0.2	4 ± 1
Remaining asc. acid (%)[1]	**30 ± 3**	**61 ± 4**

[1] *Percentage of the initial content: 2.4 ??????mg/g of fresh parsley*

Day 0

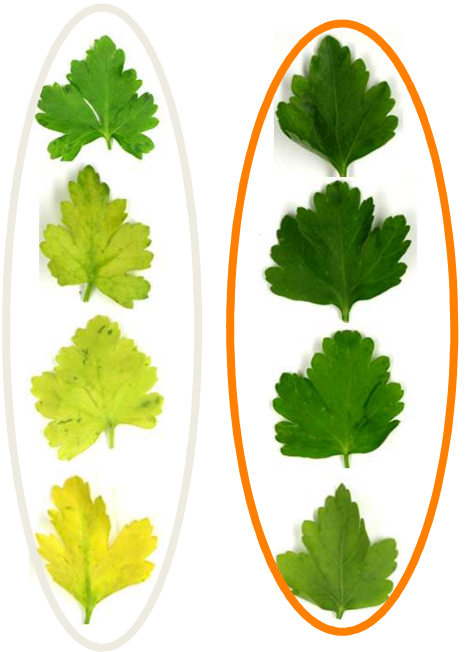


Day 2

Day 4

Day 6

Day 8



INTELLIGENT FOOD PACKAGING

INDIRECT INDICATORS

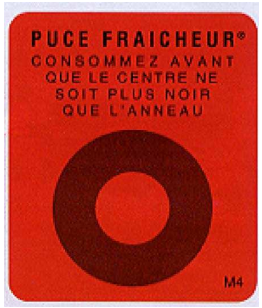
OF FOOD QUALITY

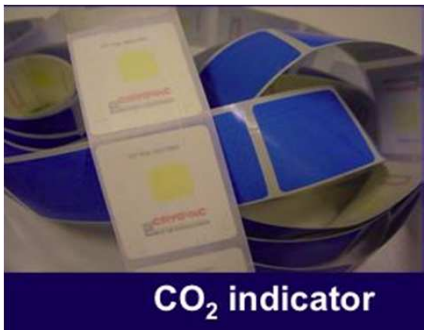
Storage conditions: T°, time, O_2, CO_2…

Critical temperature indicators

Time -Temperature indicators

Leak indicators





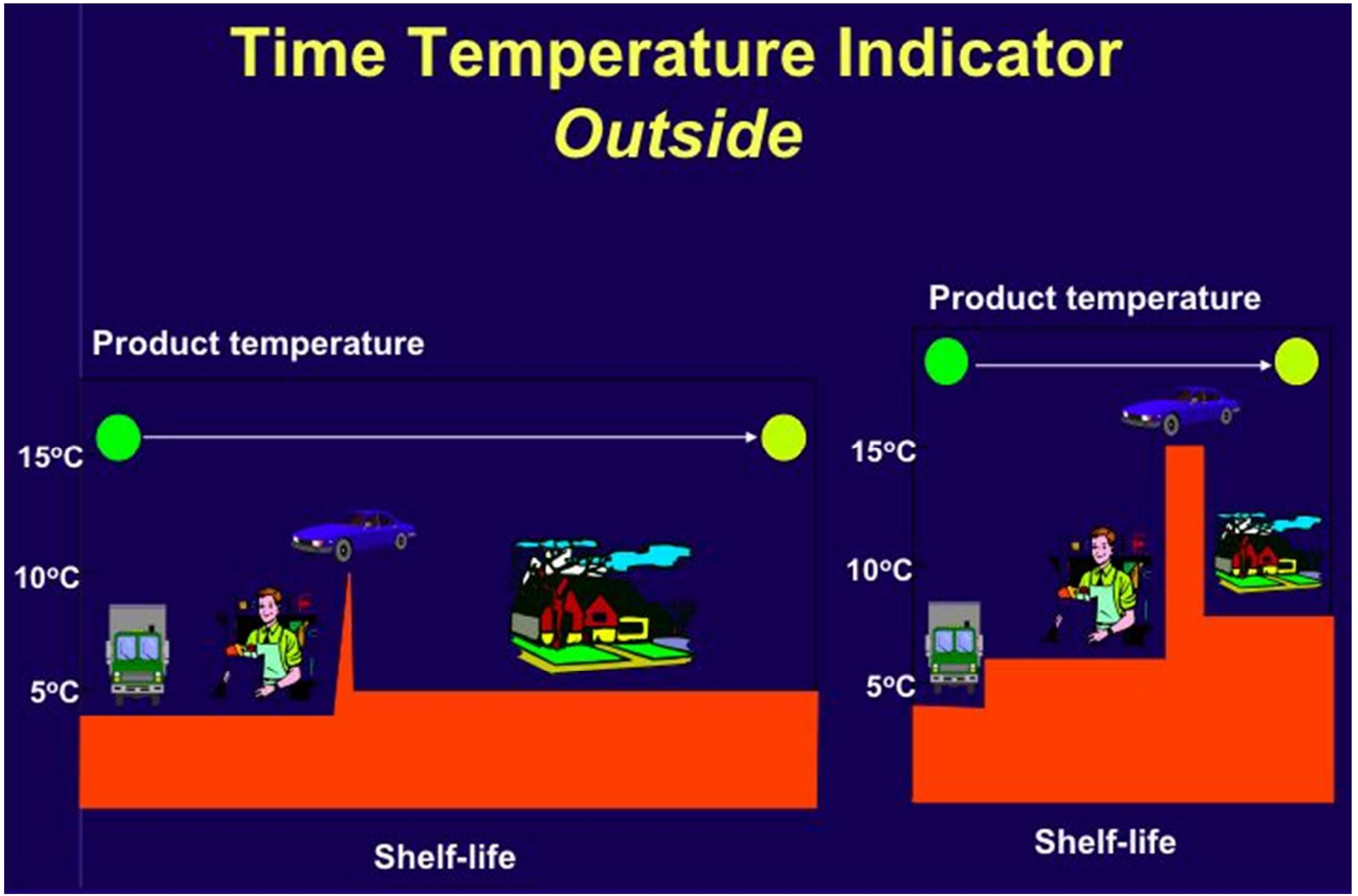
Rate of polymerisation, diffusion, chemical, enzymatic reactions..

Commercial time-temperature indicators

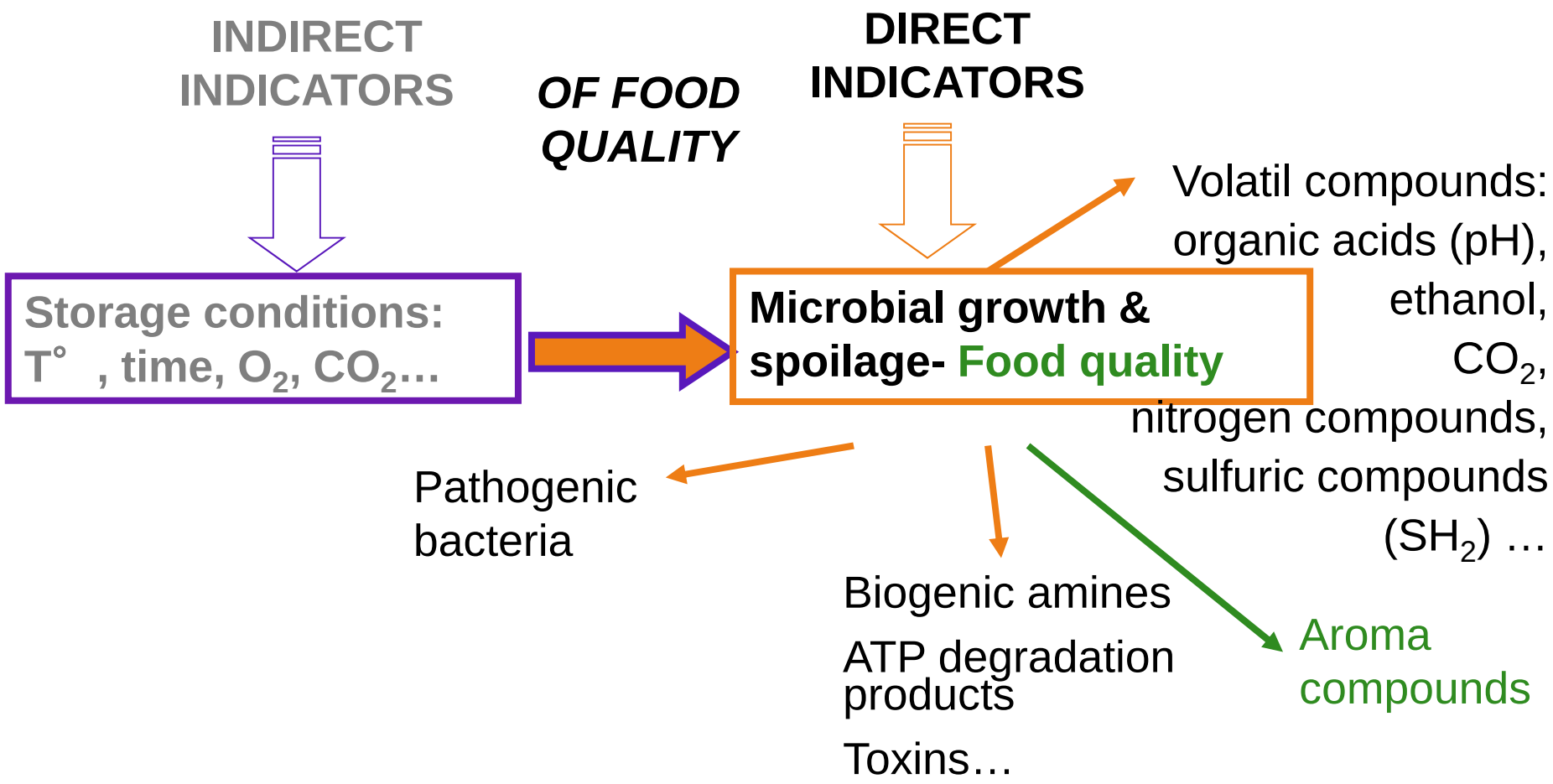
Fresh-Check, LifeLines Technology

VITSAB

3M, Company


Time Temperature Indicator
Outside
Product temperature
15°C
10°C
5°C
Shelf-life
Product temperature
15°C
10°C
5°C
Shelf-life

INTELLIGENT FOOD PACKAGING



INTELLIGENT FOOD PACKAGING

INDIRECT INDICATORS

OF FOOD QUALITY

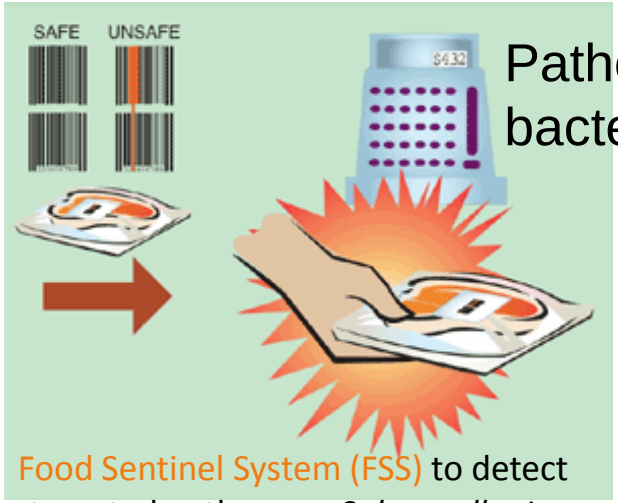
DIRECT INDICATORS

Storage conditions: T°, time, O_2, CO_2…

Microbial growth & spoilage- Food quality

Volatil compounds: organic acids (pH), ethanol, CO_2, nitrogen compounds, sulfuric compounds (SH_2) …

Pathogenic bacteria



Food Sentinel System (FSS) to detect targeted pathogen : *Salmonella, L. monocytogenes* or *E. coli*

Plastic layer loaded with specific anti-body of targeted pathogen

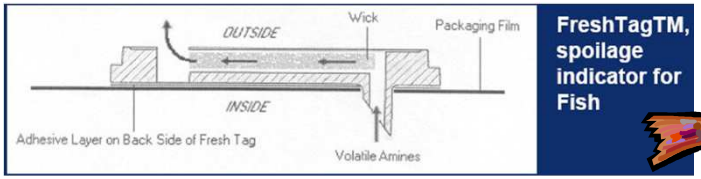
Toxin Guard (Toxin Alert Inc.)

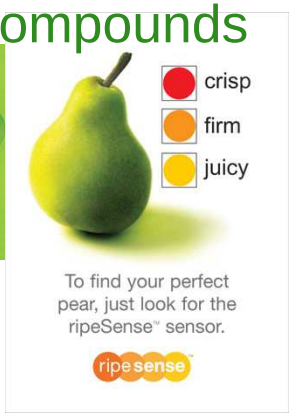
Biogenic amines

ATP degradation products

Toxins…

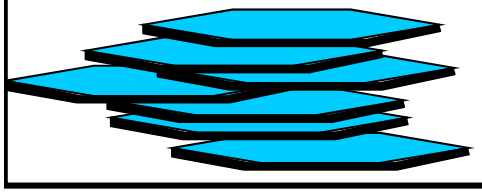
Aroma compounds



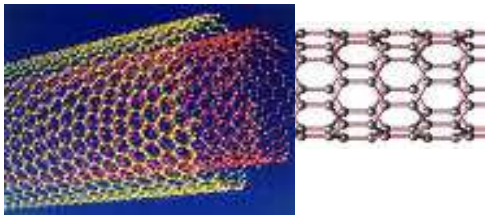


Les nanotechnologies: source d'innovation dans le domaine des emballages alimentaires actif et intelligent

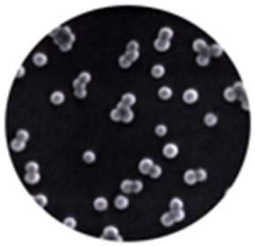
2 D (1 nano-dim)



1 D (2 nano-dim)



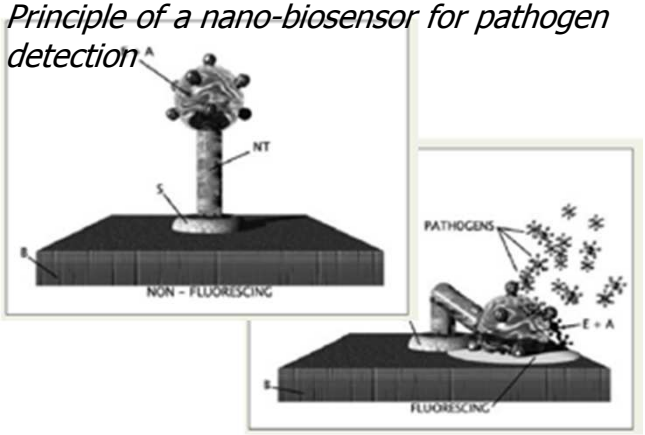
0 D (3 nano-dim)



Nanocomposites: nanoclays, nanotubes, nanofibres for reinforcing resistance and barrier properties of conventional and bio-polymers

Nanosensors for Intel. FCM detecting substances or micro-organisms

Principle of a nano-biosensor for pathogen detection

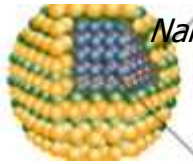


Nano-active FCM: nanoparticles, nano-encapsulated substances for controlled release

Others: adhesives etc.

Nanosilver sucette

Nanocapsule



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Merci pour votre attention

Des questions ?