Decontamination methods of food surfaces

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INDEX

NEW CONSUMER PREFERENCES

- FRESH
- LOW PROCESSED
- FAST AND EASY PREPARATION
- SAFE
- NATURAL (no additives)
- HEALTHY

NEW MARKET OPPORTUNITIES

Minimally processed foods

- Foods ready to be consumed
- Prepared Foods (fresh-cut and sous-vide)

What is a minimally processed food?

A minimally processed food is that subjected to a mild preservation treatment that allows the shelf life to be lengthened without a great modification of its original or differentiating characteristics (e.g.. Organoleptic, nutritional…. properties).

Highly Perishable Products

1. Problems

MINIMALLY PROCESSED PRODUCTS

Highly Perishable Products

Optimal Characteristics

Sensorial

Nutricional

Microbiological

NEW

Alternative?

DECONTAMINATION TECHNOLOGIES

Conventional preservation methods: loss of quality

Surface decontamination

- **<u>Causes</u> of surface cross-contamination :**

- Food handlers
- Food processing equipments
- Environment
- Food-to-food

→ Contamination of the food surface

Decontamination methods → Food surfaces

~~Product "cold" zone: food damage due to inadequate process~~

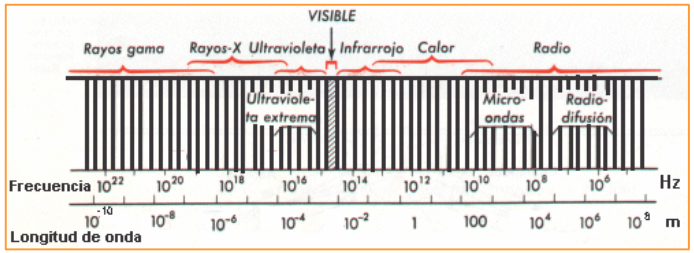
Classification of decontamination methods on food surfaces

1. THERMAL TREATMENTS :

1.1. PHYSICAL TREATMENTS

-Infrared radiation
-Steam (VSV)
-DIC

2. NON- THERMAL TREATMENTS:



2.1. PHYSICAL TREATMENTS

-UV radiation
-Pulsed light
-DIC

2.2. CHEMICAL TREATMENTS

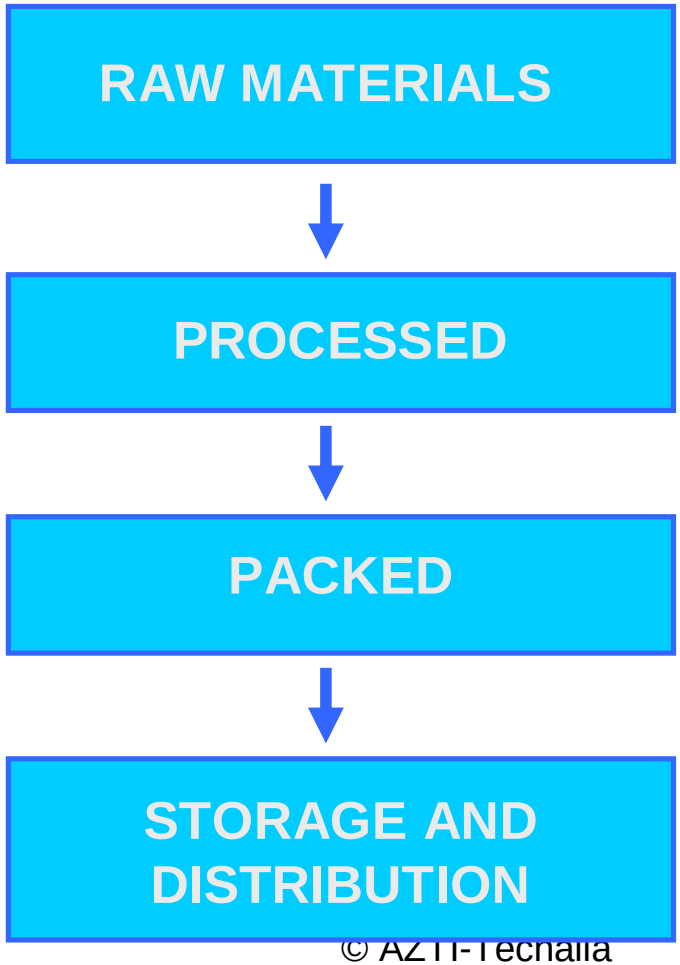
-Ozone
-Food Preservatives (Food additives: E-)
-Biopreservation
-Edible coatings

2.3. COMBINED CHEMICAL AND PHISICAL TREATMENTS

-Active packaging

NEW DECONTAMINATION TECHNOLOGIES

When?



Infrared
Steam (VSV)
DIC
UV radiation
Pulsed Light
Ozone
Edible coatings
Biopreservation
Food preservatives

UV radiation
Pulsed Light
Steam (VSV)
Active Packaging

Thermal treatments (Physical treatments)

Infrared heating

Wagelength: 700 nm – 10^6 nm

Food decontamination: short (760-2.000 nm) and media (2.000-4.000 nm)

Surface pasteurization: Thermal inactivation process

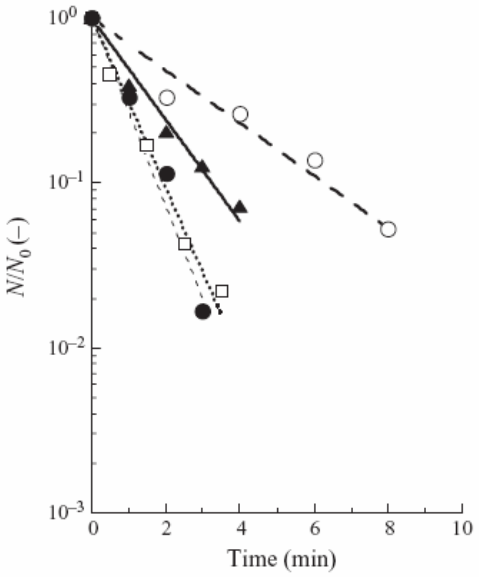


Figure 6 Inactivation of *Escherichia coli* by FIR heating at different temperatures. ○: 56 °C, ▲: 58 °C, △: 60 °C, ●: 61 °C

Related works: Sawai *et al*. 2003

***E.coli;* IF treatment inactivation rate at diferent temperatures**

STEAM PASTEURIZATION

Steam pasteurization :

http://www.foodprocessing-technology.com

-Water steam: ~ 97ºC

- Time: 6-12 seconds

- Atmospheric pressure

STEAM PASTEURIZATION

Related works: Retzlaff *et al.* (2004); Chen *et al*. (2007); Blair *et al.* (2006)

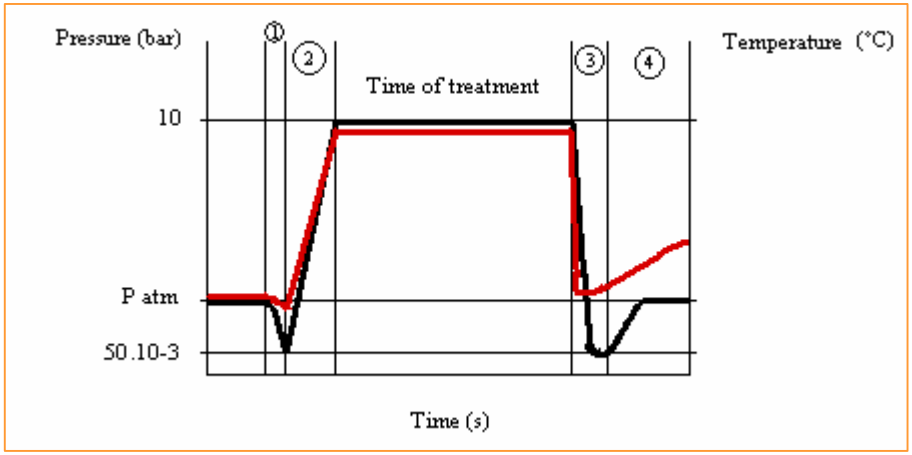
Beef extract Treatment parameters: 93.3ºC; 6 s Retzlaff *et al.* (2004)	>1.0 log CFU/cm^2 -*E.coli* O157:H7 -*Salmonella thyphimurium* - *Listeria innocua*
Pork skin Treatment parameters: commercial steam; 30 s Chen *et al*. (2007)	-*Listeria monocytogenes* ->4.38 log CFU/cm^2
Pork pieces Treatment parameters: 83ºC; 15 s Blair *et al.* (2006)	-*E.coli* O157:H7 >2.4 log CFU/cm^2 -*Salmonella thyphimurium* >1.5 log CFU/cm^2

IMPROVED STEAM PASTEURIZATION

Steam pasteurization → Thermal damage on highly perishable foods

Improved treatment: Steam combined with vaccum

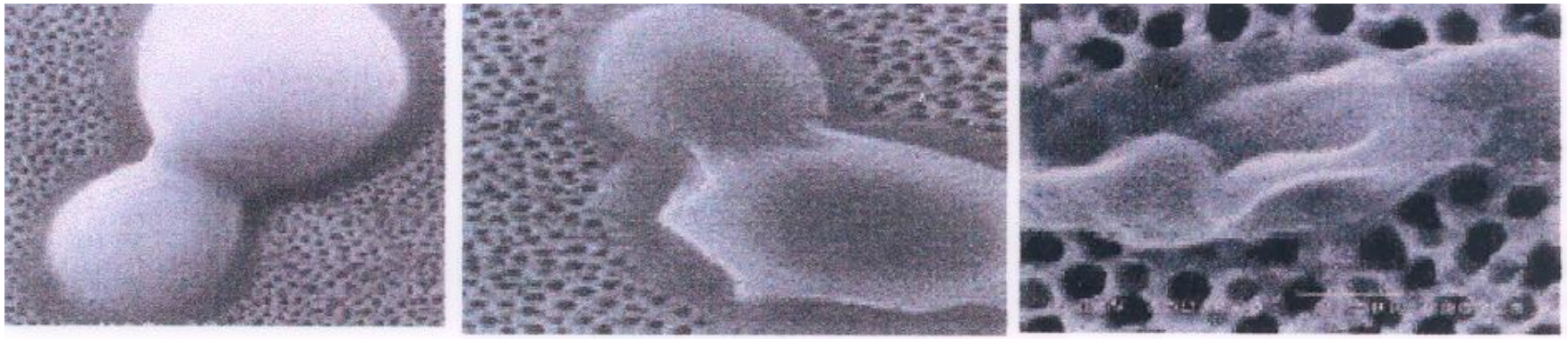
-**VSV** (vacuum-pressure-vaccum)
-**DIC** (instantaneous pressure drop)



DIC

- Combined treatment of pressure (<20 bar) and temperature
- Instantaneous Pressure drop
- Mecanism of inactivation: Cell volume increase à bursting:

Microorganism death

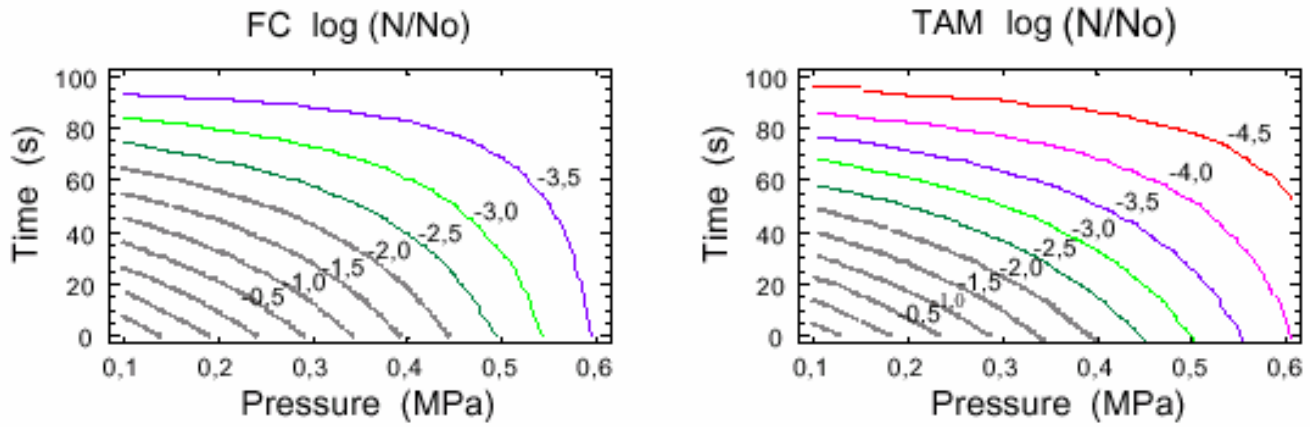


Non- treated microorganism | Thermal treatment | DIC treatment

Debs-Louka (2000)

DIC

Reported works: Pérez *et al*. (2004)

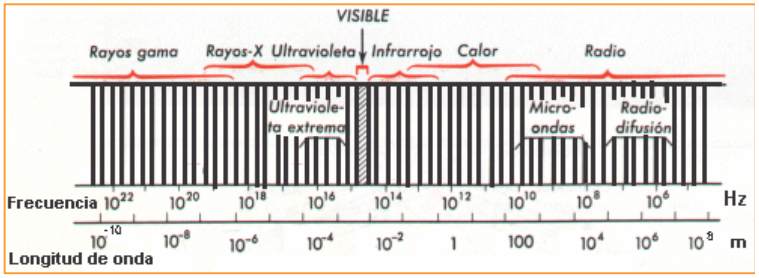


COD

Non-Thermal treatments
Physical treatments

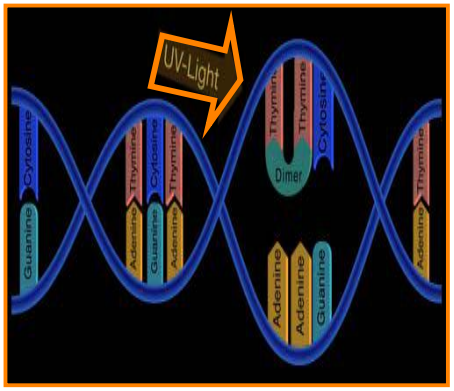
UV radiation

UV radiation wagelenght: 180nm-400 nm

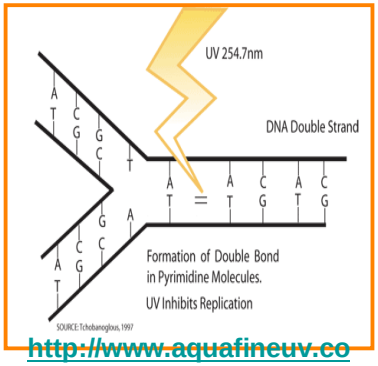


Microbial inactivation : **UV-C:190-280 nm**

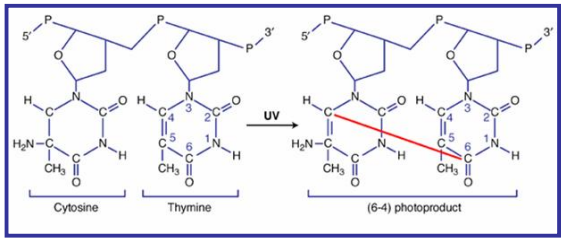
Mecanism of inactivation: **UV-light damages the microbial DNA by forming thymine dimers and, consequently, it prevents the microorganism DNA transcription and its replication**

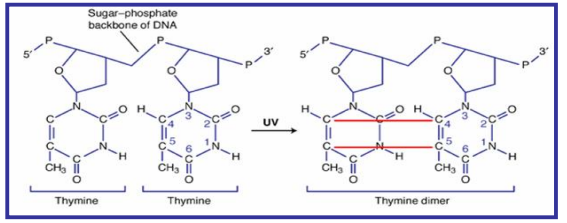


http://www.buyaquavantage.com/images/DNA.jpg



http://www.aquafineuv.com





UV radiation

Related works: Young *et al.* 2004

Treatment parameters: UV-C: Doses ranging 1.5-24 mW/cm²

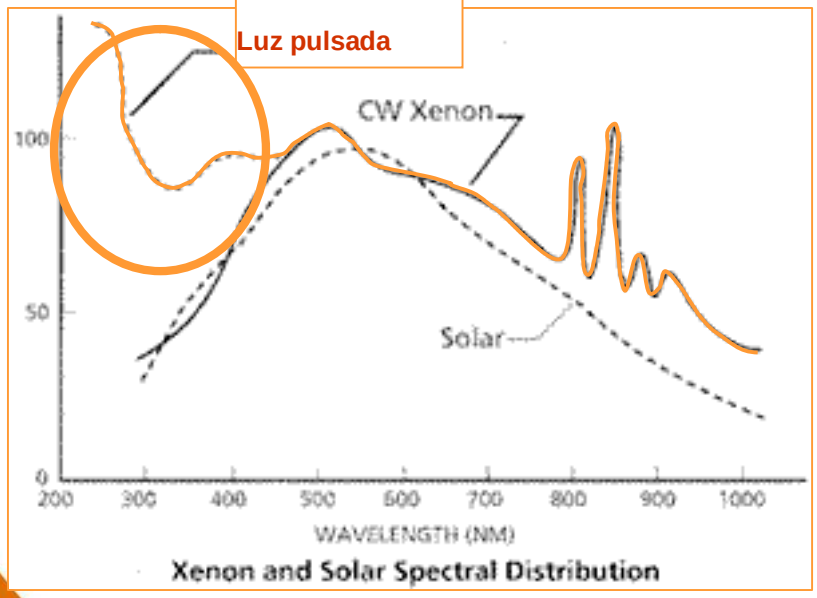
APPLE	*E.coli* O157:H7 **3.3** log CFU/cm²
TOMATO	*Salmonella* spp. **2.19** log CFU/cm²
LEAF LETTUCE	*Salmonella* spp. **2.65** log CFU/cm² *E.coli* O157:H7 **2.79** log CFU/cm²

Pulsed light

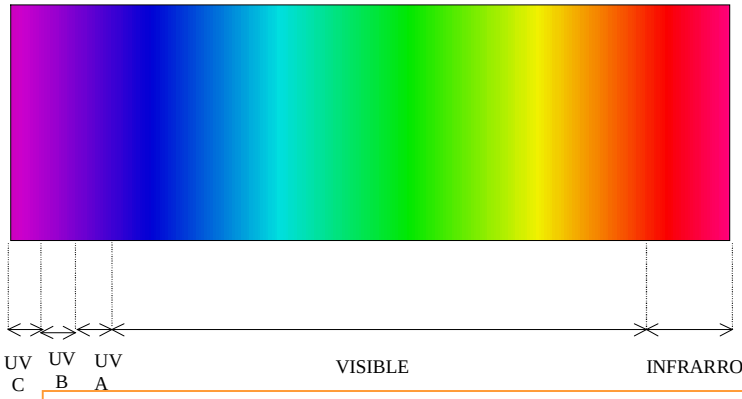
Pulsed light: (λ = 200 nm-1000nm) Intense light flashes (ms).
Short exposition time (less chemical and sensorial spoilage of the product)
Mecanism of microbial inactivation:-the same than UV radiation and cell menbrane permeability damage

Xenón

Luz pulsada



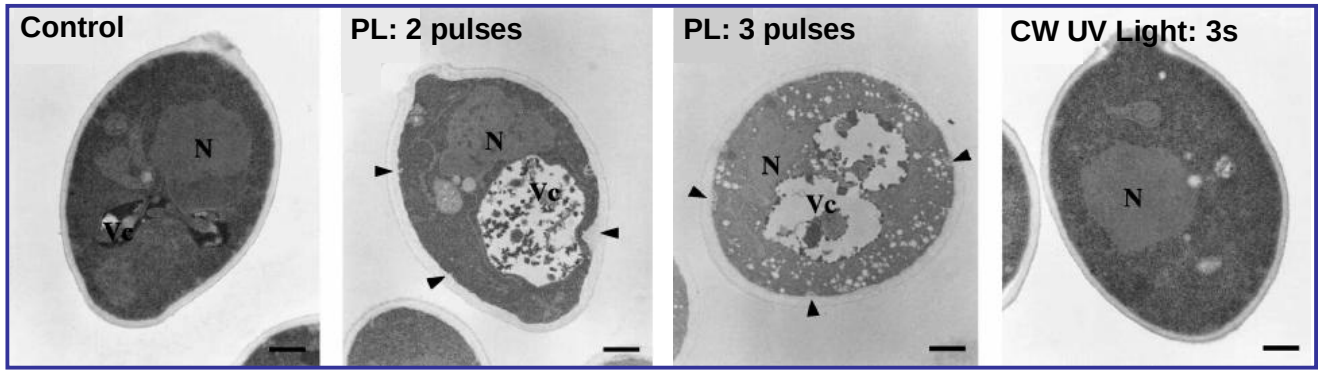
Xenon and Solar Spectral Distribution



Light Spectre (200 - 1000 nm)

Capobianco R.A. (1998-2001). PerkinElmer Opto-electronics

Pulsed Light



Takeshita et al. (2003)

Pulsed Light

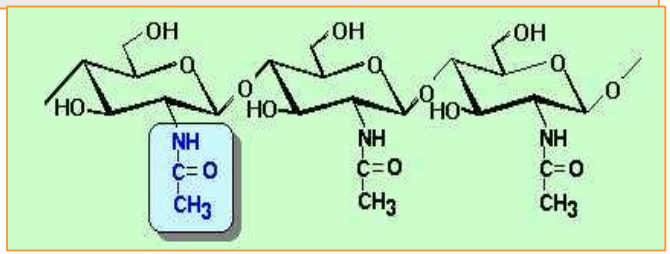
Related works: Ozer *et al*. 2006

-Inoculated salmon fillets

-Treatment parameters: 5.6 J cm^2 per pulse; 8 cm distance; 60 s

Microorganism	Reduction rate (log_{10} CFU/g)
E. coli O157:H7	1.09
Listeria monocytogenes	1.02

Non-thermal treatments: Chemical treatments



OZONE

-Ozone is a powerfull oxidizing agent, secondly only to fluorine.
Mecanism of inactivation: destruction of the cell menbrane

-Ozone inactivates viruses, bacteria, spores, fungi, algae and protozoos

Related works: Selma *et al.* (2007)

- ***Shigella sonnei*** *inoculated* in shredded lettuce

-Treatment parameters: **1 min; 10ºC**

Ozone concentration (ppm)	Reduction rate (log CFUmLl)
1.6	3.7
2.2	5.6

FOOD PRESERVATIVES

- Addition of natural antimicrobials as food ingredients.

- Derived from lactic acid: Sodium and potassium lactate

Lactates act as bacteriostat by increasing the lag phase of microorganisms.

Approved additives for Fresh produce : Spanish regulation, *Real Decreto 142/2002*

E-300: Ascorbic acid:
E-301 Sodic Ascorbate
E-302 Calcic Ascorbate
E-330 Citric acid:
E-331 Sodium citrate

BIOPRESERVATIVES

Groups of biopreservatives:

-Microbial origin (microorganims, metabolites)

-Vegetable origin (aromatic plants,spices, ...)

-Marine origin (chitosan, ...)

- Others (milk, ...)

Microbial origin

1.Protective cultures – Lactic bacteria (BAL) – active or inactive starters. *Lactobacillus coryniformis, Lactobacillus plantarum, Lactobacillus casei, Lactobacillus acidophilus, Lactobacillus reuteri, Lactobacillus sanfrancisco, Lactobacillus pentosus, Lactobacillus delbrueckii, Lactobacillus rahmnosus, Pediococcus pentosaceus, Pediococcus acidilactici, Lactococcus lactis, Streptococcus lactis*

2. Bacteriocins (Nisine, pediocine, ...), organic acids, H_2O_2, diacetyl, short-chain peptides (reuterine), fatty oils

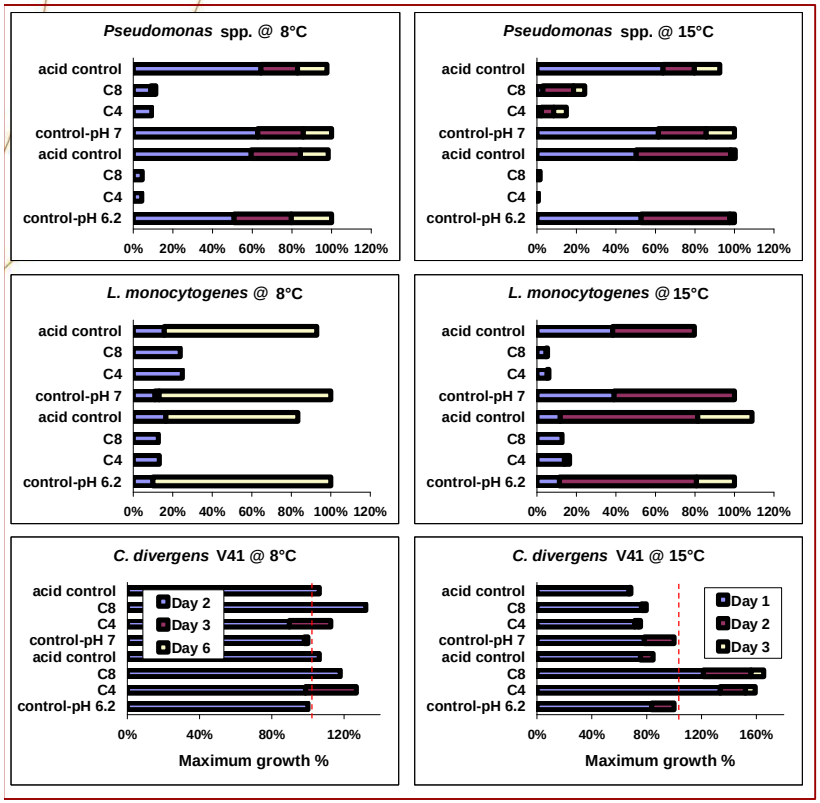
BIOPRESERVATIVES

CHITOSAN

¿New biopreservative for minimally processed products?

- main derivative of the quitin (most abundant biopolymer in the world after celulose)
- Chitosan is considered G.R.A.S.
- Antimicrobial effect of Chitosan has been widely shown in several literature surveys.(Roller, 2003)

BIOPRESERVATIVES



Chitosan formulations shows **antilisteria** activity in culture media formulated by minimally processed fish products.

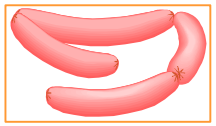
EDIBLE COATINGS

Classification:

- Hidrocoloids: with proteins (colagen, gluten, casein,...), celulose derived, alginates, pectins, almidons or others polisacarids (chitosan,...)
- Lipids: with waxes, acylglycerols y fatty oils
- Compounds: with hidro colloidal and lipid compounds

Functions:

- Barrier: control of gas permeability.
- Oxidation, loss of aromas or humidity.
- Mechanical support.
- Incorporation of antioxidants or antimicrobials.



Non-thermal treatments: Physico-Chemical treatments

ACTIVE PACKAGING

Functions:

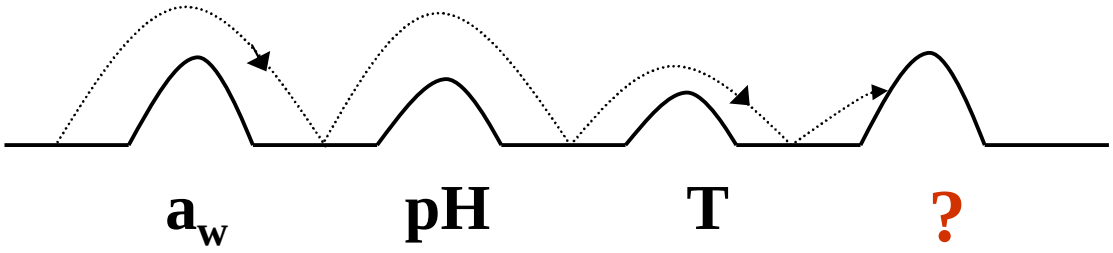
- **Oxygen captors:** Concentration objective < 0,1%
- **Antioxidant liberators** and **antimicrobial agents:** sachets that liberate ethanol vapours
- **Humidity regulators:** semi permeable, films anti-vapour, absorbers (sandwich)
- **Semi permeable** regulate the atmosphere of CO_2 and O_2




- Selection of the **appropriate technology** according to the **desired characteristics** for the final product

- **HURDLE TECHNOLOGY:** The combination of different decontamination methods or “barriers” may be much more effective that the use of each of them separately

Lower intensity → Better quality



Related works: Hurdle technology

-**Bari *et al.* 2005:** Combined Efficacy of Nisin and Pediocin with Sodium Lactate, Citric Acid, Phytic Acid, and Potassium Sorbate and EDTA in Reducing the *Listeria monocytogenes* Population of Inoculated Fresh-Cut Produce.

-Yun *et al.* 2006: Effect of combined ozone and organic acid treatment for control of *Escherichia coli* O157:H7 and *Listeria monocytongenes* on lettuce.

-Ukukua *et al.* 2005: Use of hydrogen peroxide in combination with nisin, sodium lactate and citric acid for reducing transfer of bacterial pathogens from whole melon surfaces to fresh-cut pieces.

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