

Decontamination methods of food surfaces



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1. **Problems**
2. **Classification of decontamination methods**
3. **Conclusions**

NEW CONSUMER PREFERENCES

NEW MARKET OPPORTUNITIES



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

Minimally processed foods

Foods ready to be consumed

Prepared Foods (fresh-cut and sous-vide)

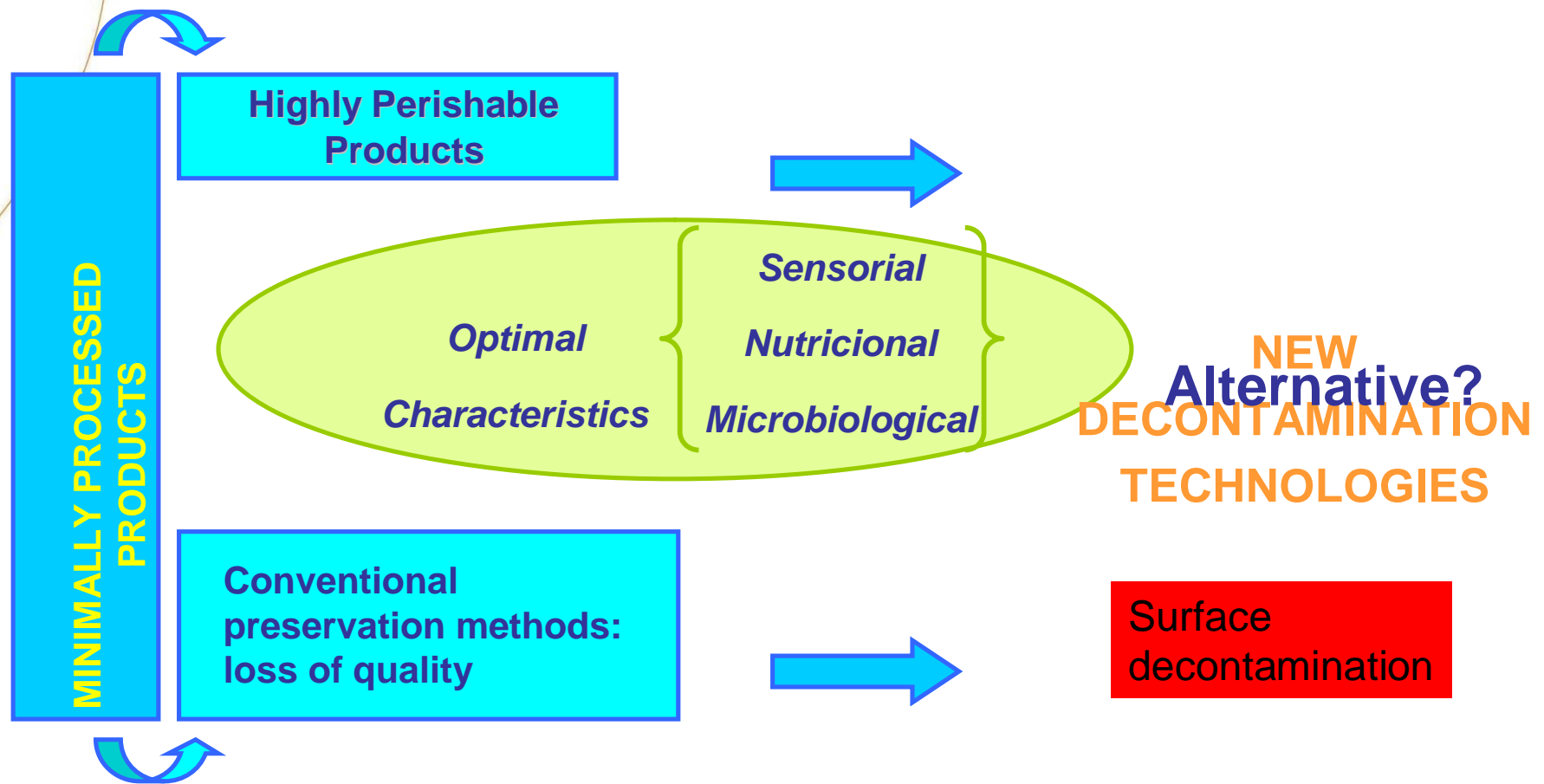
What is a minimally processed food?

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





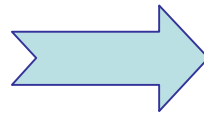
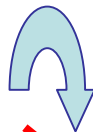
• Causes of surface cross-contamination :

- 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~~

1. THERMAL TREATMENTS :

1.1. PHYSICAL TREATMENTS

- Infrared radiation
- Steam (VSV)
- DIC

2. NON- THERMAL TREATMENTS:

2.1. PHYSICAL TREATMENTS

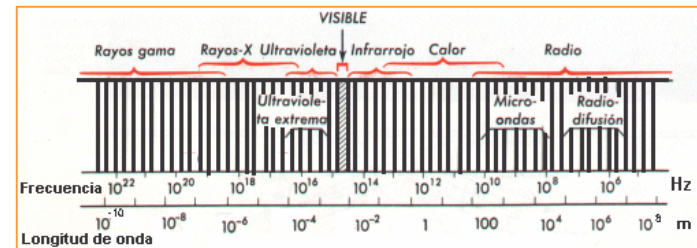
- UV radiation
- Pulsed light
- DIC

2.2. CHEMICAL TREATMENTS

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

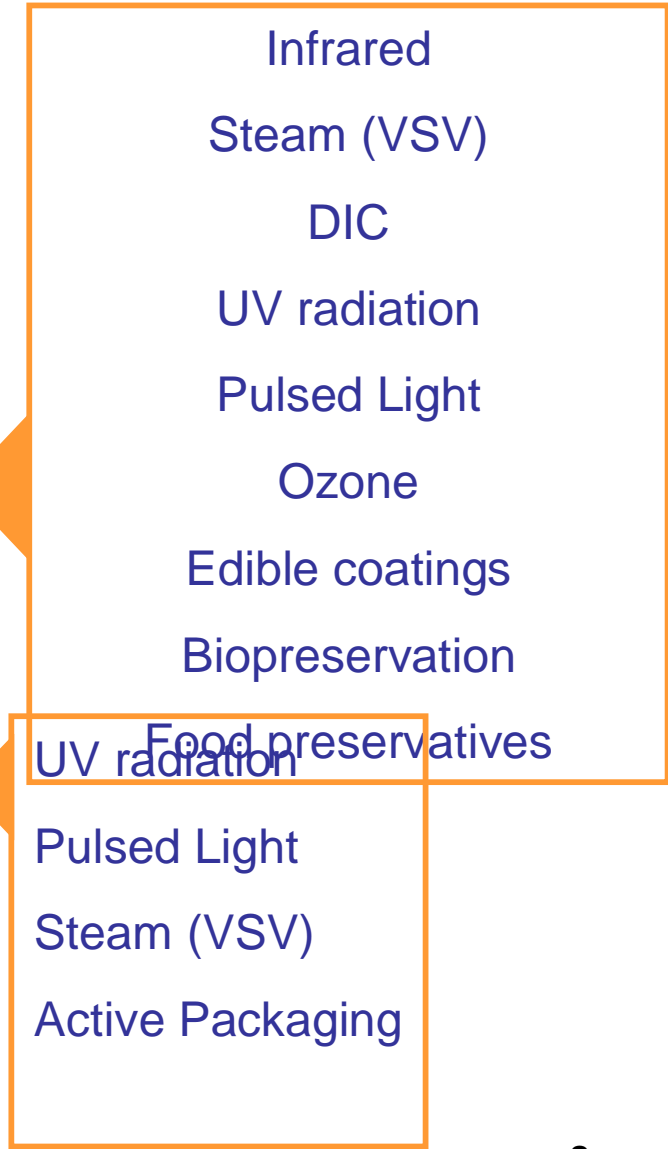
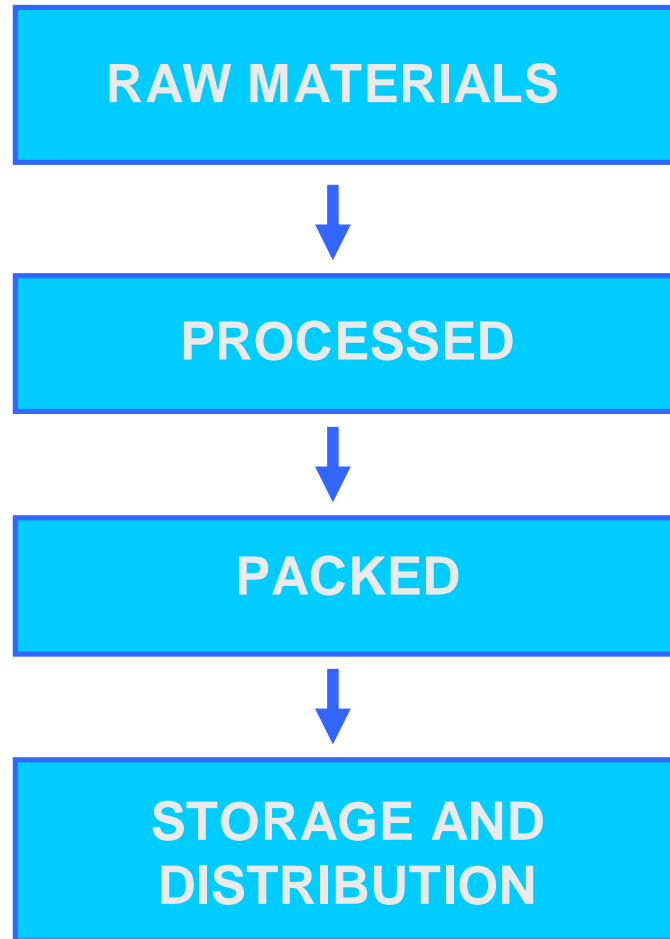
2.3. COMBINED CHEMICAL AND PHISICAL TREATMENTS

- Active packaging



NEW DECONTAMINATION TECHNOLOGIES

When?



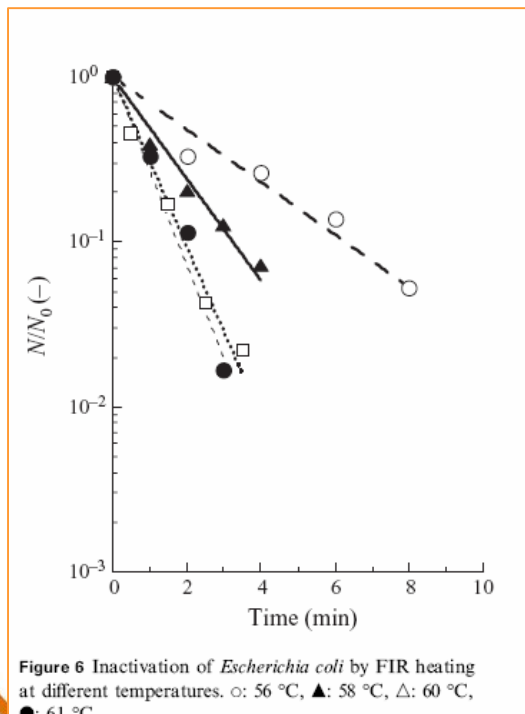
Thermal treatments (Physical treatments)



Wavelength: 700 nm – 10⁶ nm

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

Surface pasteurization: Thermal inactivation process



Related works: Sawai *et al.* 2003

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

Steam pasteurization :



<http://www.foodprocessing-technology.com>

- Water steam: ~ 97°C
- Time: 6-12 seconds
- Atmospheric pressure

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

<u>Beef extract</u> Treatment parameters: <u>93.3°C; 6 s</u> Retzlaff <i>et al.</i> (2004)	<u>>1.0 log CFU/cm²</u> - <i>E.coli</i> O157:H7 - <i>Salmonella thyphimurium</i> - <i>Listeria innocua</i>
<u>Pork skin</u> Treatment parameters: <u>commercial steam; 30 s</u> Chen <i>et al.</i> (2007)	- <i>Listeria monocytogenes</i> - <u>>4.38 log CFU/cm²</u>
<u>Pork pieces</u> Treatment parameters: <u>83°C; 15 s</u> Blair <i>et al.</i> (2006)	- <i>E.coli</i> O157:H7 <u>>2.4 log CFU/cm²</u> - <i>Salmonella thyphimurium</i> <u>>1.5 log CFU/cm²</u>

IMPROVED STEAM PASTEURIZATION

Steam pasteurization



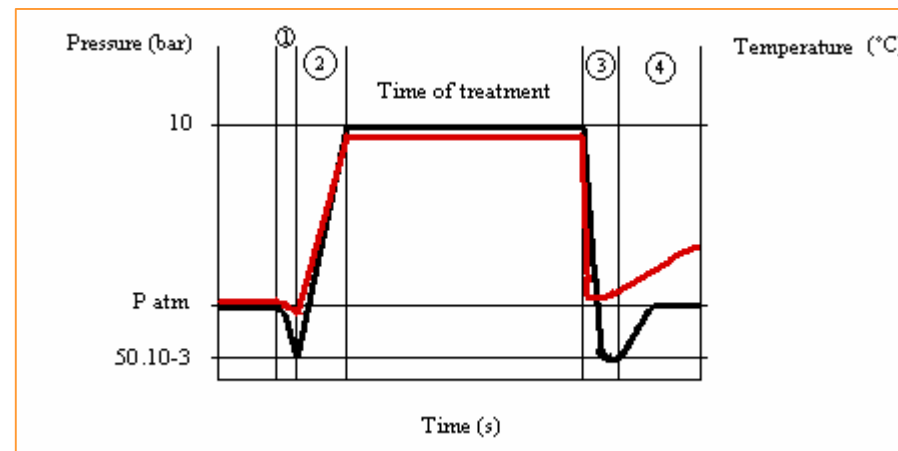
Thermal damage on highly perishable foods



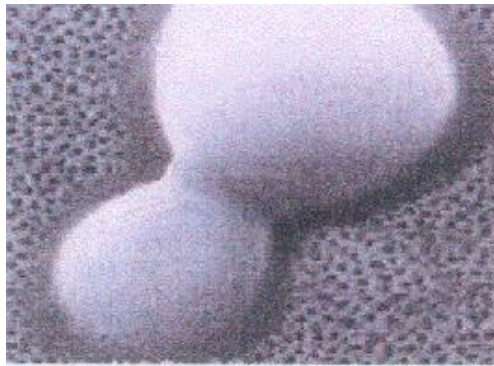
Improved treatment: Steam combined with vacuum

-VSV (vacuum-pressure-vacuum)

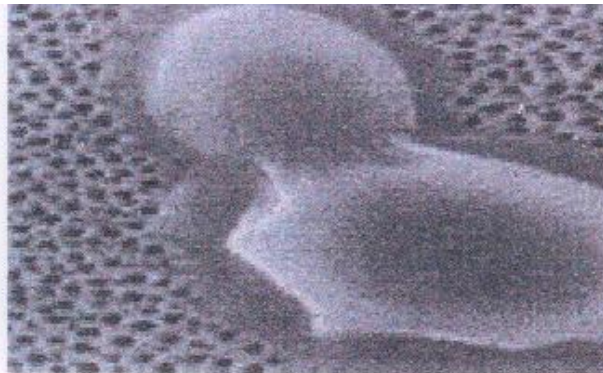
-DIC (instantaneous pressure drop)



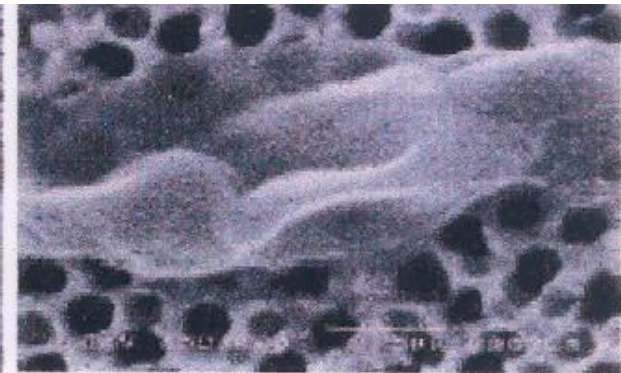
- Combined treatment of pressure (<20 bar) and temperature
- Instantaneous Pressure drop
- Mecanism of inactivation: Cell volume increase à bursting:
Microorganism death



Non- treated
microorganism

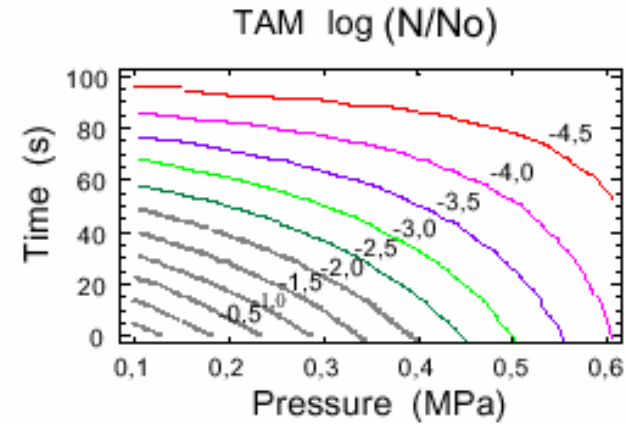
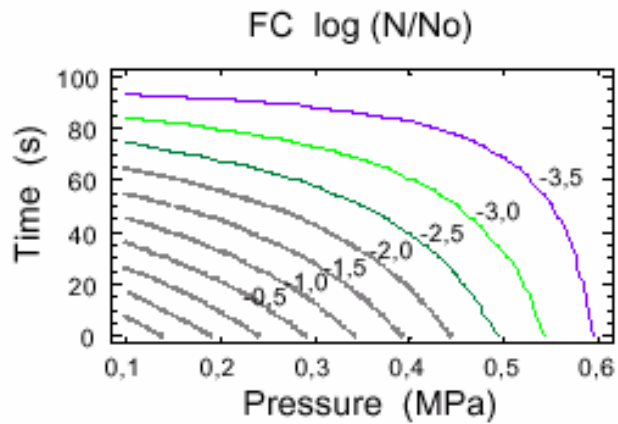


Thermal treatment



DIC treatment

Reported works: Pérez *et al.* (2004)



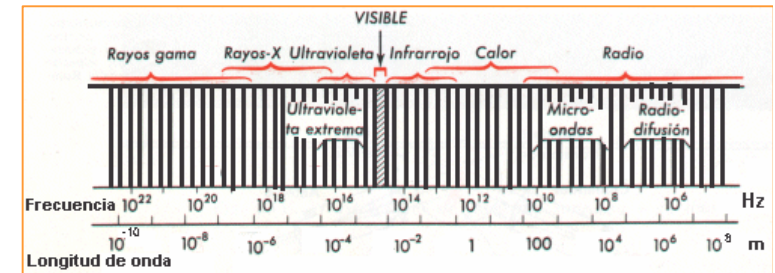
COD

Non-Thermal treatments Physical treatments

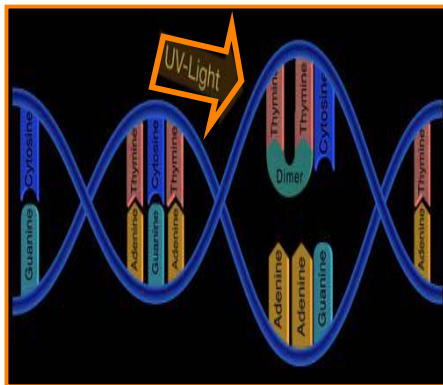


UV radiation wavelength: 180nm-400 nm

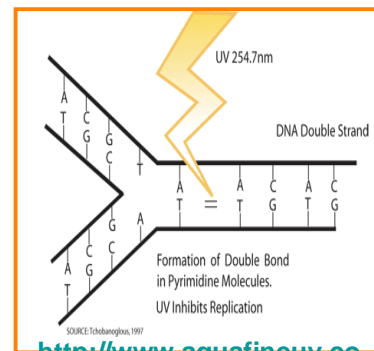
Microbial inactivation : **UV-C:190-280 nm**



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

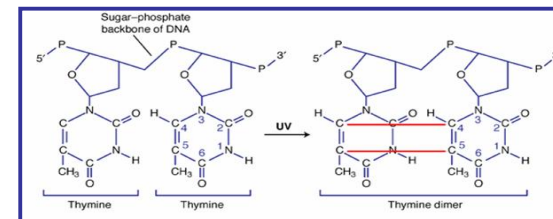
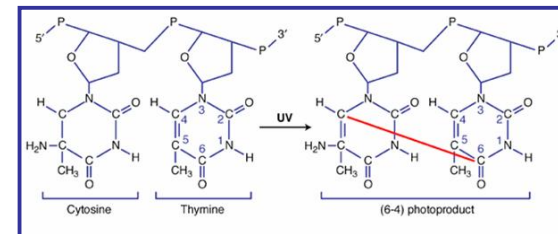


<http://www.buyaquavantage.com/images/DNA.jpg>



<http://www.aquafineuv.com>

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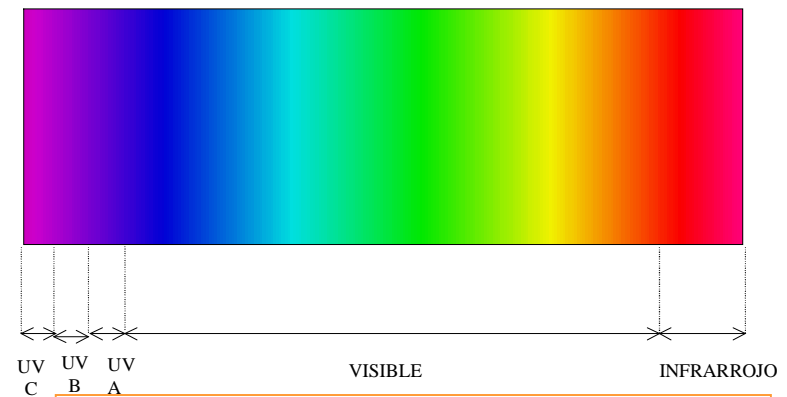
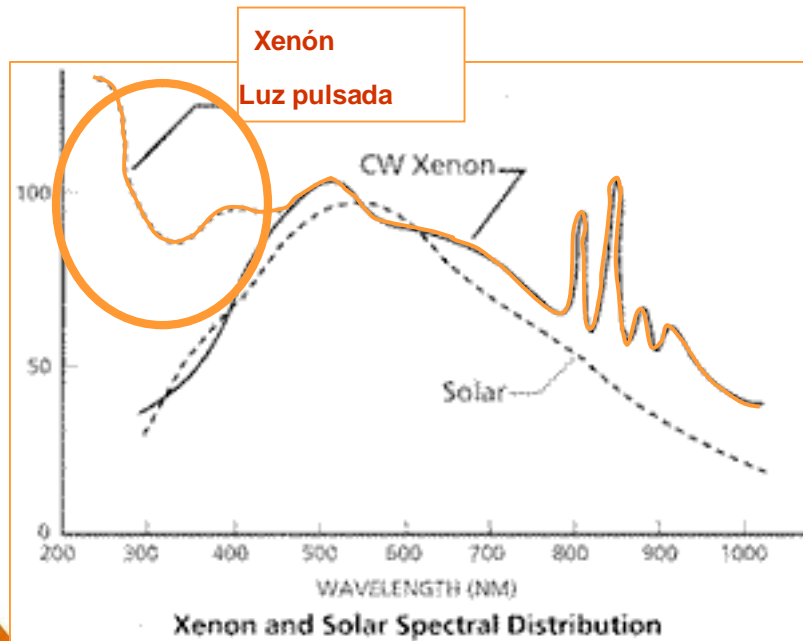


Related works: Young et al. 2004

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

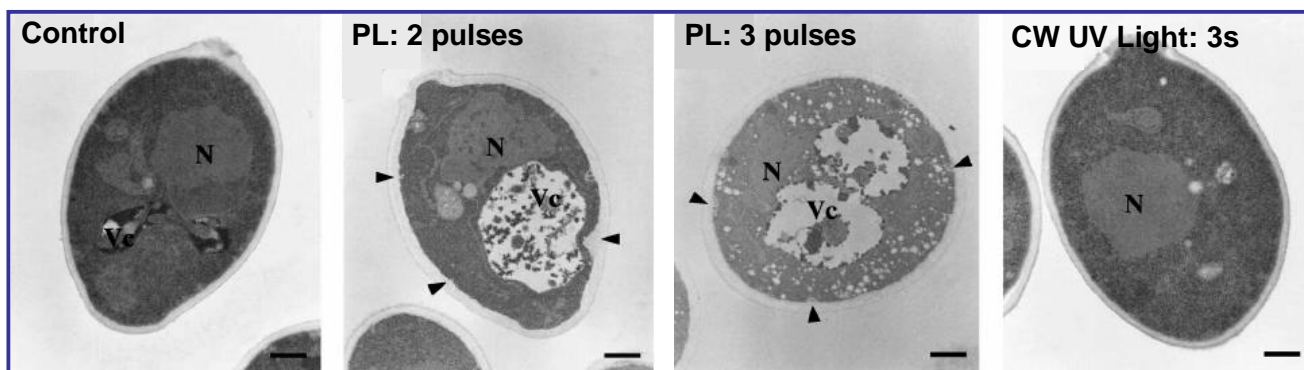
APPLE	<i>E.coli</i> O157:H7 3.3 log <u>CFU/cm²</u>
TOMATO	<i>Salmonella</i> spp. 2.19 log <u>CFU/cm²</u>
LEAF LETTUCE	<i>Salmonella</i> spp. 2.65 log <u>CFU/cm²</u> <i>E.coli</i> O157:H7 2.79 log <u>CFU/cm²</u>

Pulsed light: ($\lambda = 200 \text{ nm}-1000\text{nm}$) Intense light flashes (ms).
 Short exposition time (less chemical and sensorial spoilage of the product)
 Mecanismo of microbial inactivation:-the same than UV radiation and cell membrane permeability damage



Light Spectre (200 - 1000 nm)

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Takeshita et al. (2003)

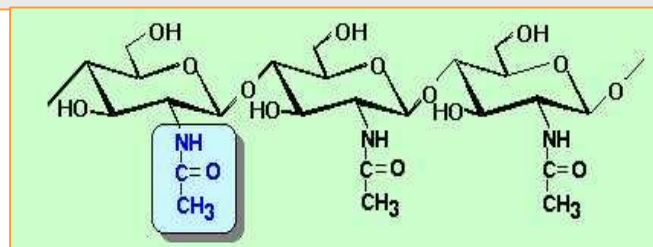
Related works: Ozer *et al.* 2006

-Inoculated salmon fillets

-Treatment parameters: 5.6 J cm² per pulse; 8 cm distance; 60 s

Microorganism	Reduction rate (log ₁₀ CFU/g)
<i>E. coli</i> O157:H7	1.09
<i>Listeria monocytogenes</i>	1.02

Non-thermal treatments: Chemical treatments





-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; 10°C**

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

- 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

Groups of biopreservatives:

- Microbial origin (microorganisms, 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*

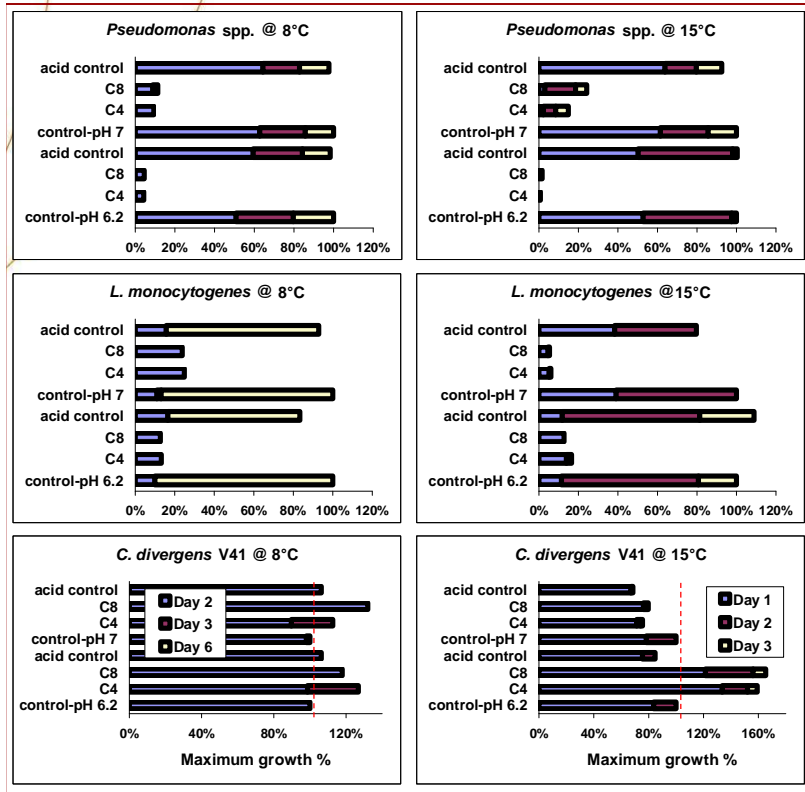
2. Bacteriocins (Nisine, pediocine, ...), organic acids, H₂O₂, diacetyl, short-chain peptides (reuterine), fatty oils

CHITOSAN



¿New biopreservative for minimally processed products?

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



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

Classification:

- Hydrocoloids: with proteins (collagen, gluten, casein,...), cellulose 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



Functions:

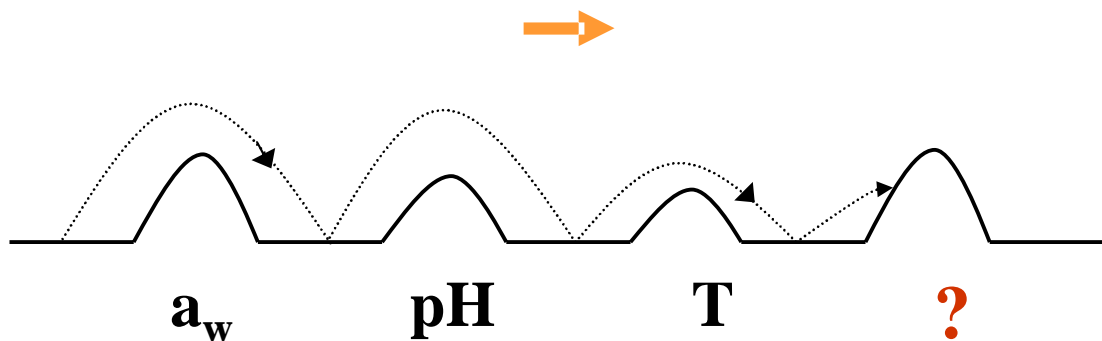
- **Oxygen captors:** Concentration objective $< 0,1\%$
- **Antioxidant liberators** and **antimicrobial agents:** sachets that liberate ethanol vapours
- **Humidity regulators:** semi permeable, films anti-vapour, absorbers (sandwich)
- **Semi permeable** regulate the atmosphere of CO_2 and O_2



- 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 than the use of each of them separately

Lower intensity

Better quality



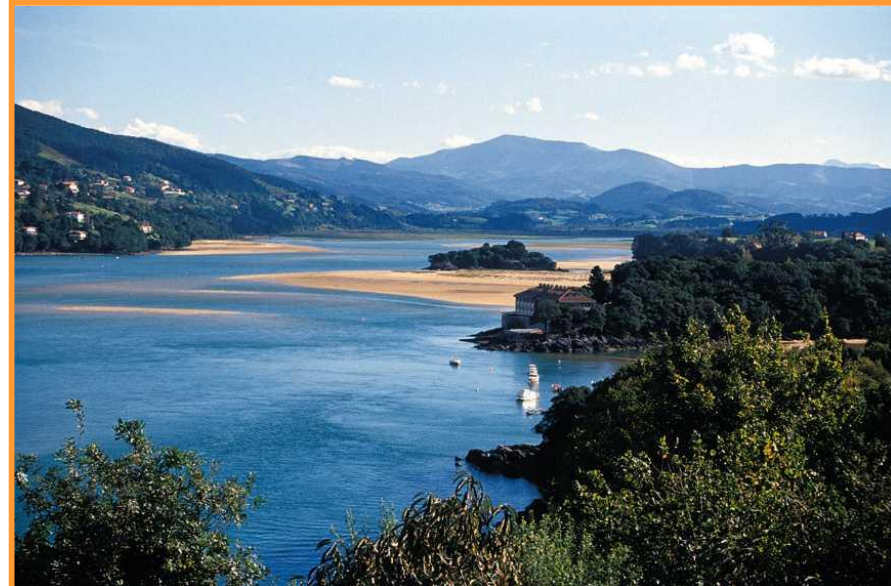
Related works: Hurdle technology

-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 monocytogenes* 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.

Iñigo
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Ziortza
Raquel
Idoia...



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