Application of QMRA to go beyond safe harbors in thermal processes. Part 1: Introduction and Framework

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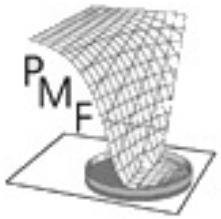
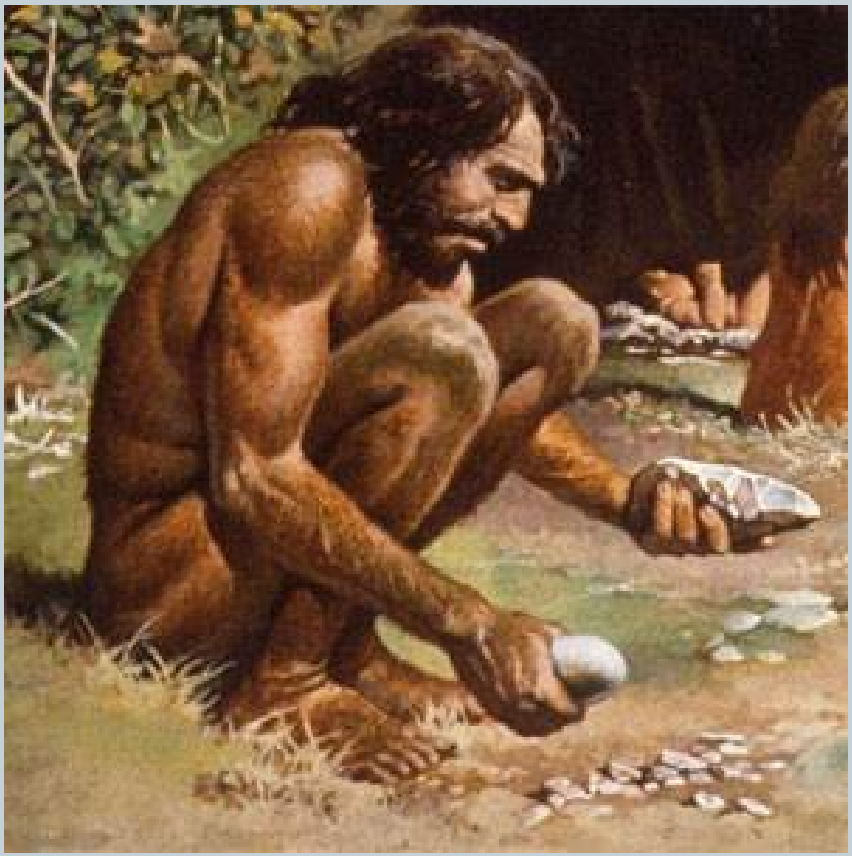
History of heat treatment in the food chain



- Changes induced on food, composition, microbiology, chemistry and physics of tissues
  - Better digestible
  - Less Toxic
  - **More durable** (Spoilage, Safety)

Discovery of fire



- Mostly anthropomorphic modifications
  - (Middle Pleistocene)
- Better digestibility of food
- Not really a rationale conservation process
- (up to 18th century : salting)

1795 : Napoleon Bonaparte

- An army “travels on its stomach”
- Prize of 12 000 francs to anyone who could invent a method of preserving food.
- Military prowess and colonial expansion required a method of keeping food unspoiled over distance and time

1810 : Nicolas APPERT

- Conservation of food in glass bottles

L'ART DE CONSERVER,

PENDANT PLUSIEURS ANNÉES,

TOUTES LES SUBSTANCES ANIMALES ET VÉGÉTALES;

Ouvrage soumis au Bureau consultatif des Arts et Manufactures, revêtu de son approbation, et publié sur l'invitation de S. Exc. le Ministre de l'Intérieur.

Par APPERT,

Propriétaire à Massy, département de Seine et Oise, ancien Confiseur et Distillateur, Élève de la bouche de la Maison ducale de Christian IV.

« J'ai pensé que votre découverte méritait » un témoignage particulier de la bienveillance » du Gouvernement. »
Lettre de S. Exc. le Ministre de l'Intérieur.

A PARIS,

Chez PATRIS et Cie, Imprimeurs-Libraires, quai Napoléon, au coin de la rue de la Colombe, n° 4.

1810.

LE LIVRE

DE TOUS LES MÉNAGES,

OU

L'ART DE CONSERVER,

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TOUTES LES SUBSTANCES ANIMALES ET VÉGÉTALES.

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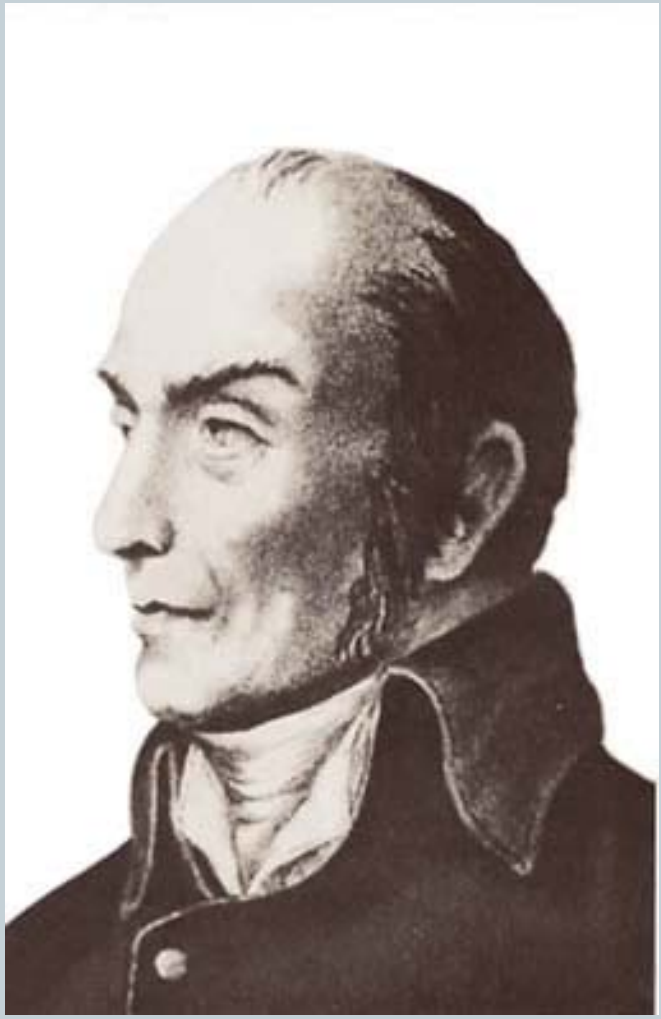
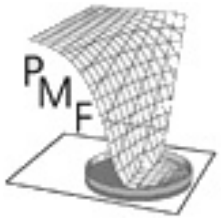


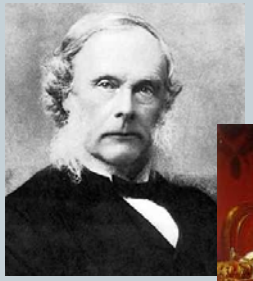
Peter Durand and the tin can



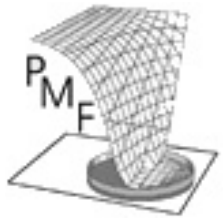
- Frenchman Pierre Durand (also known by his English name, Peter Durand) was granted a patent from King George III for the idea of preserving food.
- Durand intended to surpass Appert and fashions containers out of tinplate.
  - Made of iron coated with tin to prevent rusting and corrosion
  - Tinplate could be sealed and made airtight and was not breakable like glass
- Scientific assumption at that time : preservation in absence of oxygen

1864 : Pasteur and the germ theory

- Microorganisms are responsible for the spoilage of food
- Patent of heat treatment of wine vs. degradation by *Acetobacter*
  - *1855 : Heat treatment of 55°C*
  - *First experiments by Vergnette de la Motte*



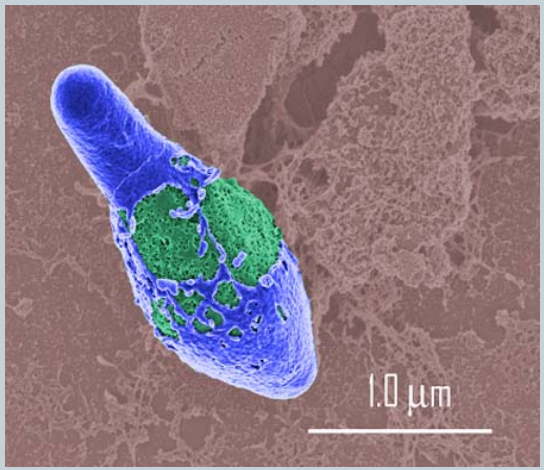
Theoretical developments mainly driven by empirism



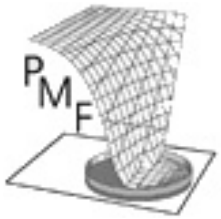
- Identification of spoilage and pathogenic bacteria
- From empirical to specific treatment
- Definition of sterilizing value (F Value)
- Thermal destruction
  - 90% destruction : the D value
  - 90% reduction of D value by temperature shift : the z value

Clostridium botulinum & low acid products

- 1897 : Prescott & Underwood
  - Scientific rationale of adulteration of canned food: bacterial spores, amongst them *Clostridium botulinum* (*Bacillus botulinus*)
- Esty & Meyer (1922), Townsend (1938), Stumbo (1965)
  - $F_0$3 botulinum cook (12 Log reduction at 121,1°C = 3 minutes)
  - 12D cook : Probability of survival of 1 cell in 1 can out of 10^{12}



Thermal reduction by high heat treatment



- F value (Ball, 1927), concept of destruction (minutes) of a microorganism at 121,1°C (250°F)
  - *C. botulinum*
    - D = 0,21min @ 121,1°C
    - 12D = 2,52 min
    - 100 spores / container >> 2,94min

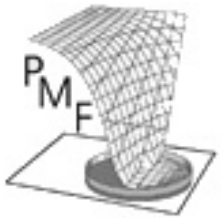
F0 value = 3.

10^{-12} spores/ can

- Approach in USA (FDA)
  - 10 000 spores / container
  - 12D process

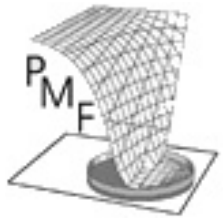
10^{-8} spores/ can

Two different type of heat treatment



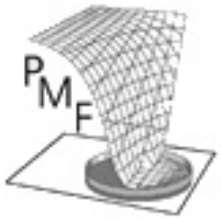
- Low heat processing
  - Pasteurization and other mild heat treatment (e.g. Thermization)
    - Target : vegetative mesophilic cells
    - Ineffective against thermophilic cells and thermoresistant spores
- High heat processing
  - Sterilization : complete destruction of microorganisms
    - Commercial sterilization : microbiologically shelf stable product with low number of dormant bacterial spores (not absence of living organisms)
  - Ultra High Temperature
    - Combination of thermal processing and aseptic packaging

Safe harbors in food industry



- Dairy Industry
- Meat Industry
- Cooked Chilled Food

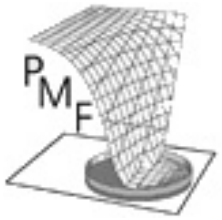
Heating of Milk



- First applied in Denmark, especially to improve flavor and quality of butter
- Used to prevent, or at least delay souring, and avoid market loss
- Improper handling of milk, and first food handler contaminations lead to extensive use of heating
- Tuberculosis of bovine origin

140°F / 60°C – 20min, or 158°F / 70°C – 1min
(New York Board of Health 3 min)

Proposed Time Temperature chart



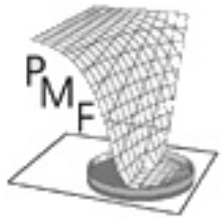
- 1912 – Kilbourne : Bovine Tuberculosis

158°F	70°C	3 min
155°F	68,3°C	5 min
152°F	66,7°C	10 min
148°F	64,4°C	15 min
145°F	62,8°C	18 min
140°F	60°C	20 min

- 1957 - Enright : *Coxiella burnetii*

161°F	71,7°C	15 s
145°F	62,8°C	30 min

Adaptation of heat treatment in dairy ?



- Heating the milk leads to thermo coagulation of serum proteins

  Economical loss

- 72°C / 15s applied 50 years ago to reach 5D reduction of *C. burnetii*

  still relevant ? (Cerf & Condron 2006)

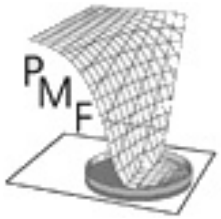
- 1983 : *L. monocytogenes* identified as food borne pathogen – Pasteurization 8D reduction (Mossel & Struijk, 1991)

  Environmental contamination mostly

  Not only initial contamination of raw material

- Proposed alternative : single thermisation (Benard, 1981) – 68°C / 15s

Safe harbors in food industry



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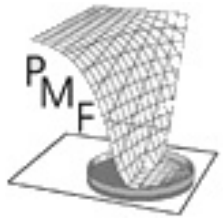
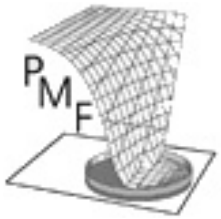
Assessment in ground meat



- United States Department of Agriculture USDA : Salmonella reduction of 7D in ready to eat (RTE) poultry products and 6,5D in RTE beef products
- United Kingdom Advisory Committee on the Microbial Safety of Food UK ACMSF : **70°C / 2min** gives 6D reductions of *E. coli* 0157H7, *Salmonella spp*. and *L. monocytogenes*
- *E. coli* as sole target organism : **70°C / 1,3 min** if 95% confidence of achieving 6D reduction deemed acceptable
- Assumption of initial bacterial load to be updated with improvement of global hygiene in food processing industries

Safe harbors in food industry



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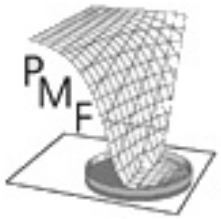
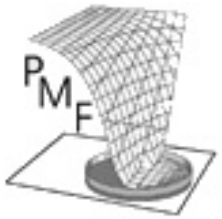
REfrigerated Processed Food with extended durability (REFPEDs)



- ACMSF (1992) : 6D process of non proteolytic *C. botulinum*

- Updated report (2008) :
  - guidelines with same level of protection with lower heat treatment and taking into account other suboptimal conditions to establish growth inhibition (Peck, 2006)

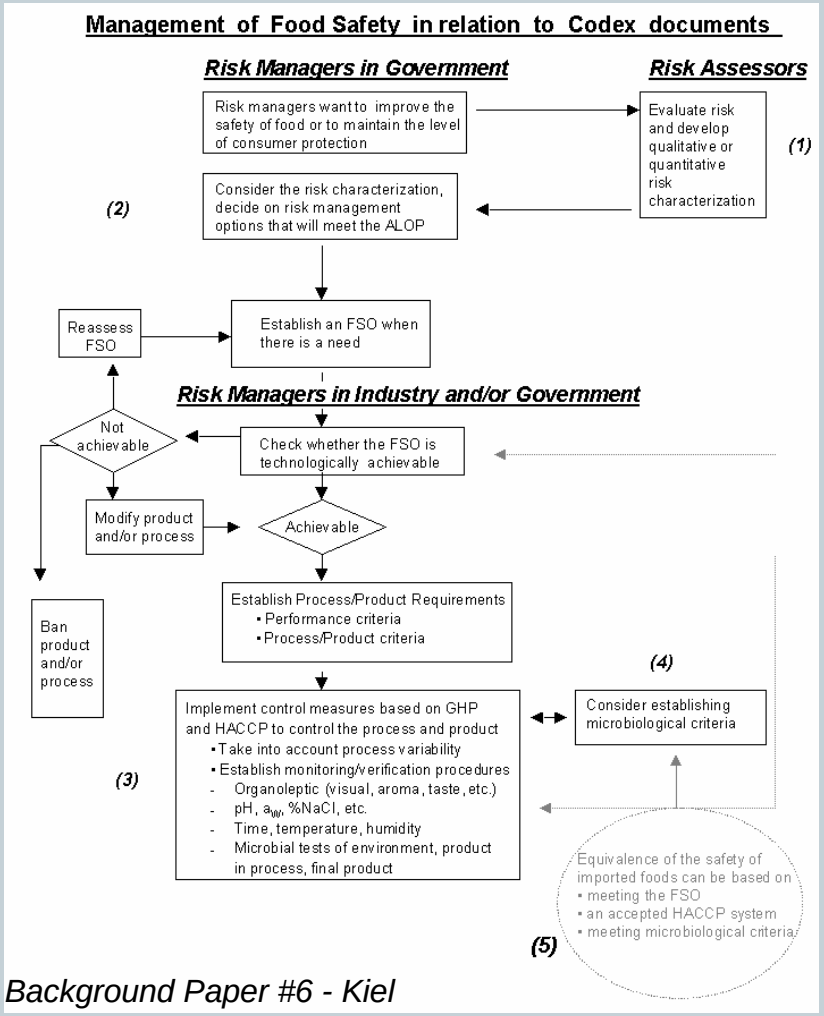
Safe Harbors



- Heat treatment in the food industry was not a health public issue to begin with
  - Longer shelf life
  - Technological standardization of versatile food products
- The rational of actual heat treatment came *a posteriori* after they were scientifically characterized and assessed

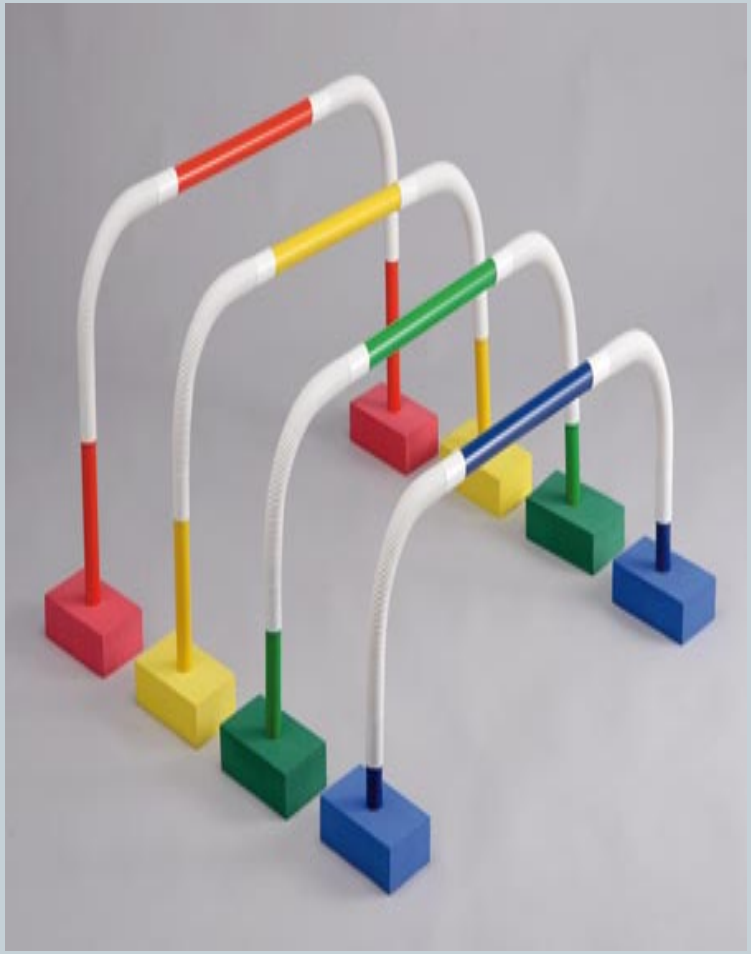
Balance Safety / Technology

- Risk / Benefit analysis
  - Heat Treatment helps reaching the food safety objective (FSO) driven by the acceptable level of protection (ALOP)
  - From an industrial point of view, it seems more adequate to consider the principle of as low as reasonable acceptable level of protection (ALARA)



Background Paper #6 - Kiel

Hurdle concept
Safety along the food process



- Objective at the end : fair practices in the food trade and protection of consumer's health
- Heat Treatment necessary but not sufficient
- Hazard analysis critical control point of one food process helps determine the place of the heat treatment for optimization of reduction of risk

Thank You for your attention

ILSI Report “RISK ASSESSMENT APPROACHES TO SETTING THERMAL PROCESSES IN FOOD MANUFACTURE” to be published in 2010