Improving the European Innovation Climate in Food Processing Research and Development

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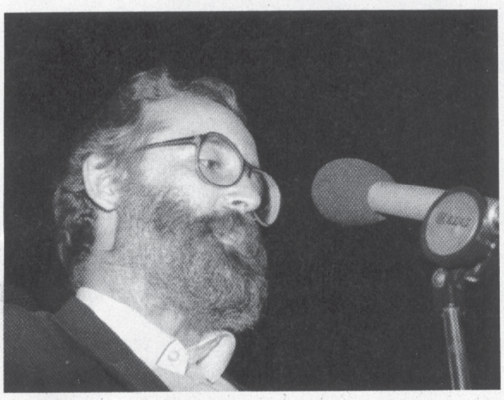


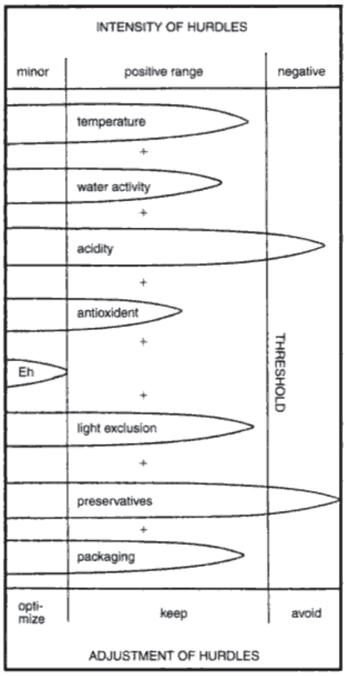
PIROKA NAGY/1956 INSTITUTE

Twenty years ago the Berlin Wall came down, as the communist regimes of eastern Europe fell one by one. Who was the first to shake its foundations? Was it cold warrior Ronald Reagan? Or Soviet reformer Mikhail Gorbachev? Well maybe they had a role. But step forward a tenacious biologist, Janos Vargha, whose campaign to halt a dam on the river Danube brought Hungarian hardliners to their knees. When reformers took over in Budapest, their first act was to cancel the dam – and their second was to open the border with Austria. As thousands of Hungarians and then East Germans flooded through, the game was up for communism. The wall fell and Europe was transformed.

The dam that broke the Berlin Wall

46 | NewScientist | 11 July 2009

Hurdle concept



HUNGARIAN SALAMI

Spices	antimic
Moisture removal	aw
Curing	pH
Smoking	aw, antimic
Drying	aw

ETP Food 4 Life

Preference
Acceptance
Needs

Reverse Engineering

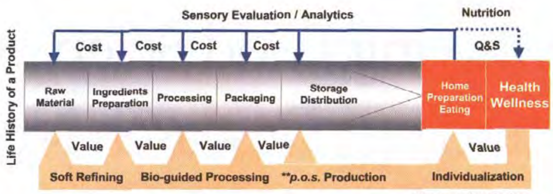


Fig. 1—The food process chain from agricultural raw materials to the final health effects of products. In more traditional processing, engineering is dominated by added functionalities for sensory and acceptance criteria and renovations designed to minimize cost throughout the production chain. Nutrition and health are properties added on as an isolated part of quality and safety to meet mandated general product compositions. As food products take on a more intimate role in the management of personal health, the wellness of the consumer becomes a key value driver, and various features of the health of the consumer will "bioguide" all of the stages of food processing, from softer refining to point of sale production and individualized benefits to the consumer.

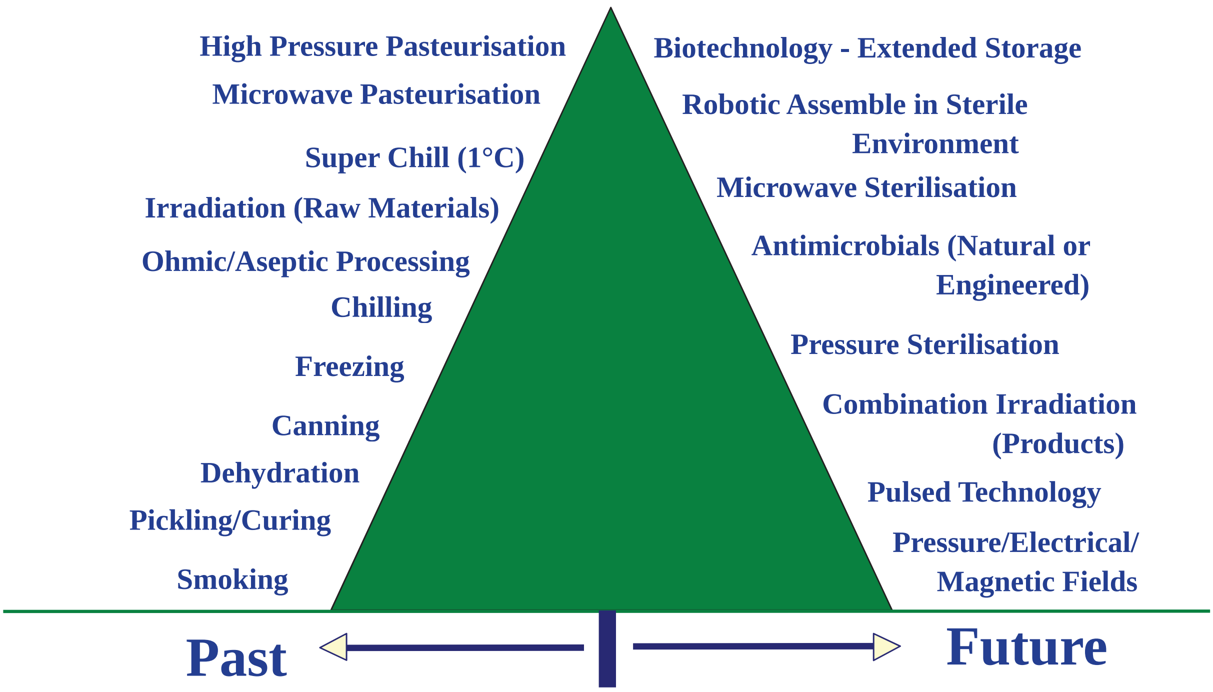
(German et al 2004)

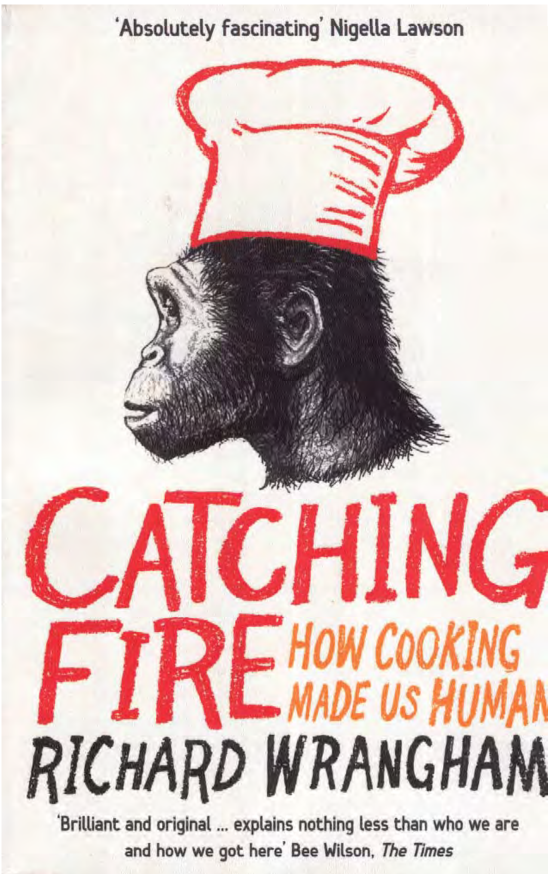
Hans Hoogland

What's cooking this summer?

INTERNATIONAL HERALD TRIBUNE
JUNE, 4-5, 2011

The Technology Hill



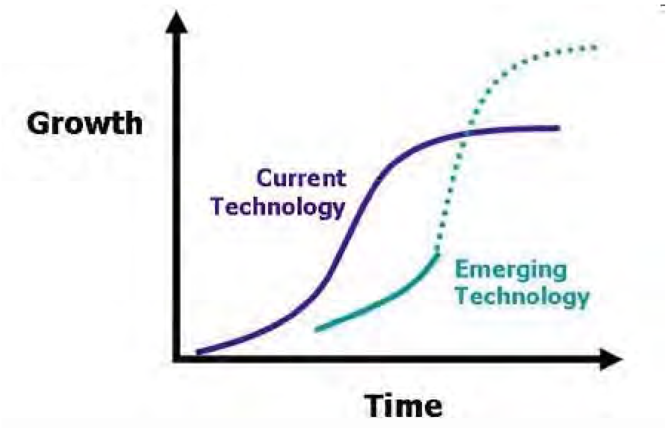


Innovation can be systematically managed – if one knows where and how to look

There are, of course, innovations that spring from a flash of genius. Most innovations, however, especially the successful ones, result from a conscious, purposeful search for innovation opportunities, which are found only in a few situations.

P. F. Drucker
Harvard Bus. Rev. 1985

The central meaning of innovation thus relates to renewal or improvement, with novelty being a consequence of this improvement. For an improvement to take place it is necessary for people to change the way they make decisions, or make choices outside of their norm.



P. F. Drucker
Harvard Bus.
Rev. 1985

BIG INNOVATIONS

WATER ACTIVITY CONCEPT

ASEPTIC – SMART – PACKAGING

HYDROSTATIC PRESSURE (activation Volume)

COMBINATION PROCESSES / MINIMAL PROCESSING

The „Top Ten" innovations in food science & technology of the past 50 years

- Aseptic processing and packaging
- Minimum safe canning process for vegetables
- The microwave oven
- Frozen concentrated citrus juices
- controlled atmosperhic packaging for fresh fruits and vegetables
- Freeze-drying
- Frozen meals
- Concept of water activity
- Food fortification
- Ultra-high temperature processing

(IFT, 1989)

Open Innovation

• Nestle;	JFS 76, R62, 2011
• GenMills;	World Wide Innovation Network (G-WIN)
• Kraft;	Innovate with Kraft

Timing

High Pressure:

1899 Hite, USA
1969 Gould et al, UK
1983 Farkas, DK, USA
1986 Hayashi, JP

WEST VIRGINIA
AGRICULTURAL EXPERIMENT STATION,
MORGANTOWN, W. VA.

BULLETIN 58. JUNE, 1899 p. 15-35

The Effect of Pressure in the Preservation of Milk.

A Preliminary Report.

By B. H. Hite.

Serial No. P CH 66 0306

ABSTRACT OF RECORD REPORT COLWORTH HOUSE

Date 11 APR 66 Author W.A. Hamilton, L.F. Parkin Investigation No. B 1034

Title NON-THERMAL EFFECTS OF PHYSICAL TREATMENT ON FOOD AND FOOD MICRO-ORGANISMS PART III. EFFECTS OF HIGH PRESSURE ON MICRO-ORGANISMS.

Vegetative cells are more resistant to pressure treatment when in milk or meat, as compared to being in aqueous suspension. To effect the same degree of kill in food media, a pressure approximately 1000 atm. greater than that used with aqueous suspension is required. Sterility of the vegetative cell population of food could possibly be achieved by 5000 atm. for 1 hr.

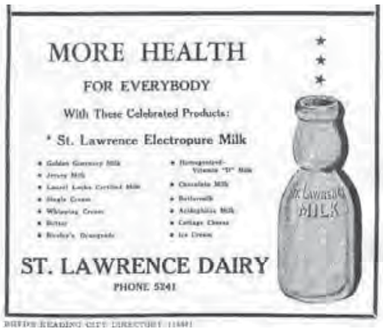
The sensitivity of spores is unaffected by the suspending medium, but is greatly affected by the temperature at which the treatment is carried out. Spores are almost completely resistant to pressure at 0°. At 60° and above, kills of 5 to 7 orders of magnitude have been found with bacillus spores at 2000 atm.

Germination and outgrowth of B. polymy M1 and B. cereus PX spores have been examined and characterized by electron microscopy and chemical analysis.

34 WEST VIRGINIA EXPERIMENT STATION.

of tubes were filled with this milk in the usual way and subjected to pressures of seven to twelve tons, and temperatures of 152°—160° F. for one to three hours. The samples were kept at the temperature of the room for ten days, when a number of them were opened and found to be sweet. Six of the remaining samples were then packed in a tin box and shipped to New York City and back by mail. Two of the samples were then opened. They were sweet. Three days later two more samples were opened, with the same result. The other two samples were kept until the morning of June 4th, when this report went to the printer. They were still sweet. The first

Timing



Pulsed electric fields:

1920 **Pasteurization of milk „*Electropure Process*"**
Ohmic Heating and free radical formation

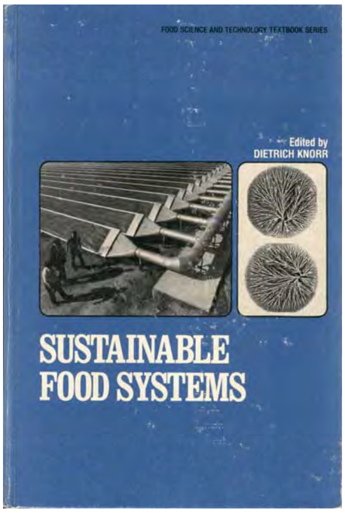
1949 **Electroplasmolysis of plant material**
B.L. Flaumenbaum, Odessa

1960 **Patent, *H. Doevenspeck***
Phase separation, non-thermal effects on microorganisms

1967 ***Sale & Hamilton***
First systematic studies, Identification of main processing parameters.

Timing

Dietrich Knorr:



- Organic foods 1982
- Amaranth 1985
- Plant cell cultures 1984
- Chitin/ Chitosan 1984
- Waste recovery 1977
- Sustainable food systems 1983
- High pressure homogenization 1990

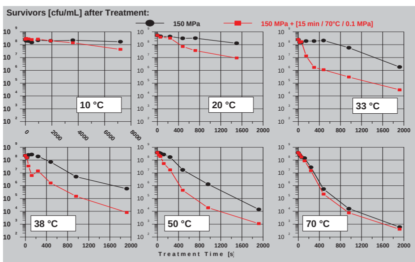
- Food Biotechnology 1985
- Non-Thermal Processes 1992

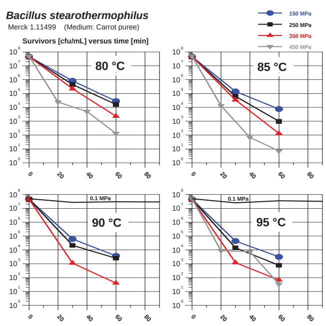
Timing

Volker Heinz / DK:

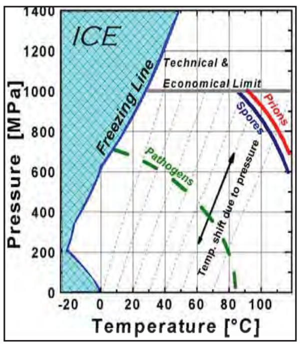
- Steam injection plus US 1993
- HP/ electric shock waves 1995
- HP sterilization 1995
- HP prions, viruses 1996
- HP process inhomogenieties 1994
- HP short time processing 1998
- PEF methodology/ equipment 1996

GERMINATION - INACTIVATION





Potential of HP for Sterilization

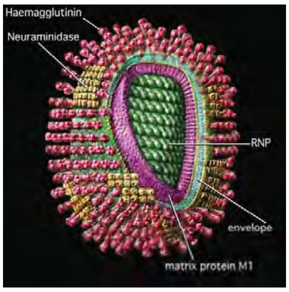


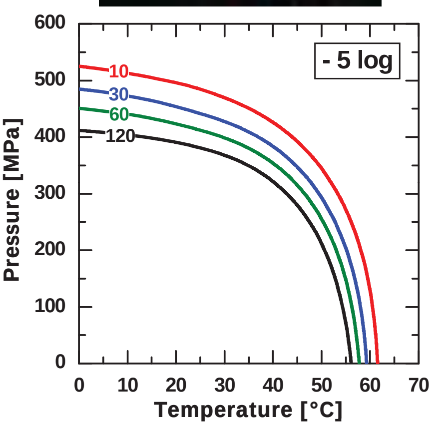
Food Biotechnology and Food Process Engineering

Timing

PATS- summary

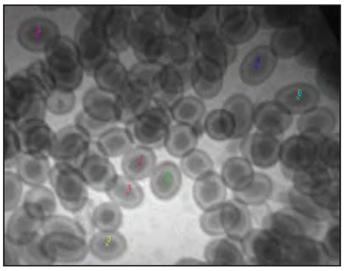
Viruses

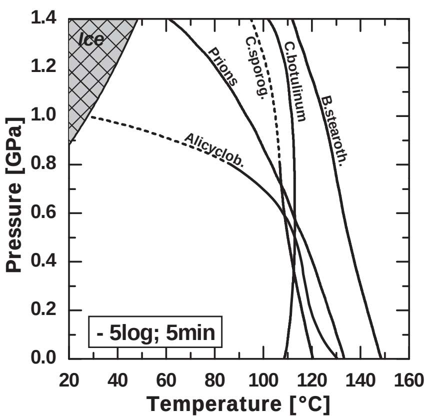




H7N7

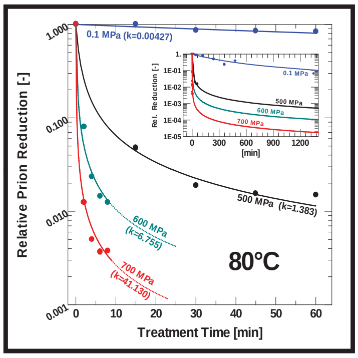
Spores





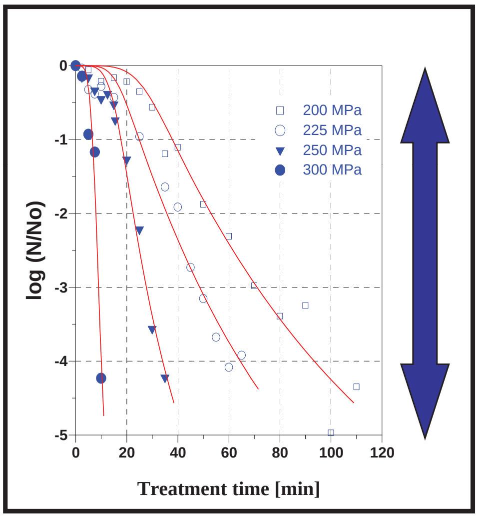
Prions

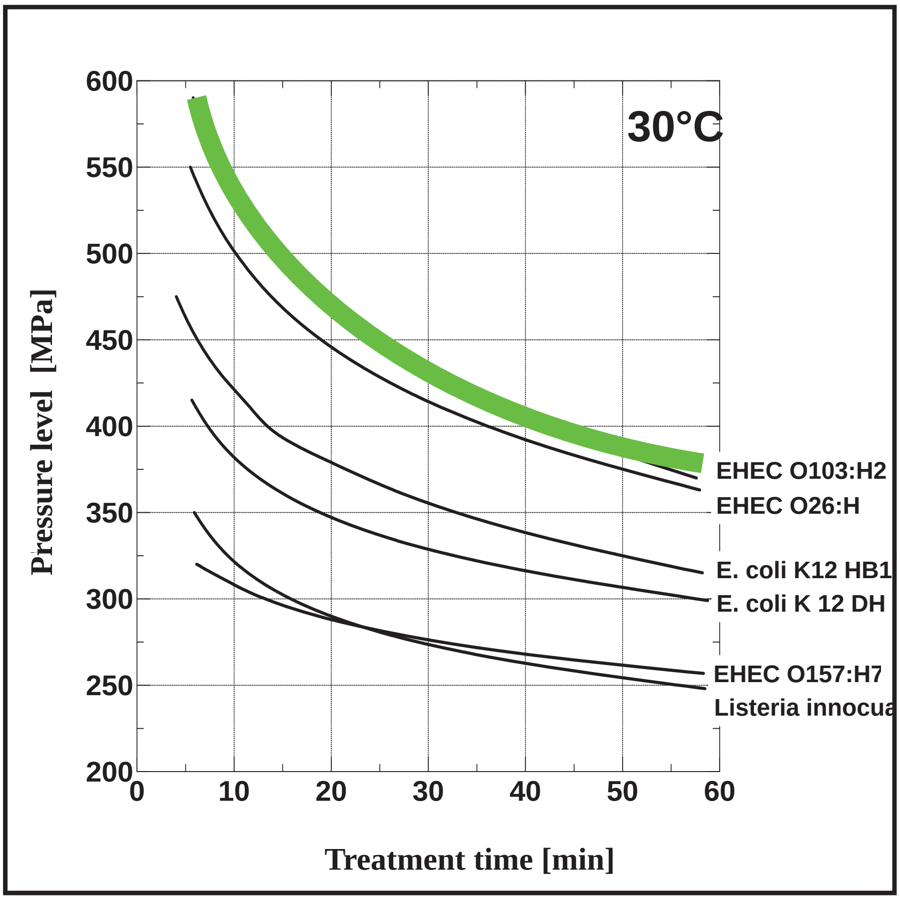
PrP^{Sc}



Minimal required reduction in microbial count:

5 log cycles





FOUR TYPES OF INNOVATIONS STUDIED

Conceptually Oriented Tasks (COTs):

- elicit students' level of understanding of key science concepts;
- identify students' misconceptions, "common sense" knowledge at odds with actual concepts that are known to affect students' learning;
- engage students in conceptual schemes within a topic rather than isolated facts; help students focus on methods of problem representation and approaches to think about the problem components (solving strategies);
- engage students with real-world problems in creative ways that reflect a conceptually integrated understanding of the content

Collaborative Learning (CL) Activities:

- engage students with peers (groups as small as pairs) as a component of the learning process;
- provide students the opportunity to engage in explanations and discussions as they describe their reasoning, interpretations, and solutions to problems.

Technology (TECH):

- helps students visualize processes and/or concepts;
- helps students manipulate variables by collecting and/or analyzing data that can help them understand a concept or a process or solve real-world problems;
- helps students test theories and models with simulated data;
- provides feedback (online homework, such as problem sets).

Inquiry-Based Projects (IBPs):

- provide students the opportunity to undertake research projects (may or may not be in a real-world setting) that require more than one class period to complete;
- require students to develop a procedure and/or plan to complete the project;
- require students to follow a structured procedure and/or plan provided in advance as a framework to complete the project.

Four types of innovation studied.

SCIENCE VOL 331 11 MARCH 2011

Innovation climate + science

Universities: engage students
(concepts, peers, mentors)

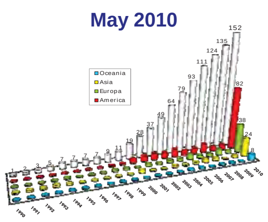
change curicula

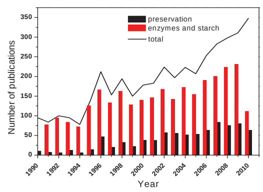
Industry: Mr. Chocolate (Trophelia)
Open Innovation (Nestle, GenMills, SME´s

Funding Bodies: deliverables
high risk projects
long term funding

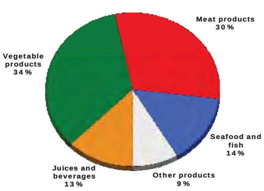
Random walks

Evolution of HPP industrial machines installed on continents

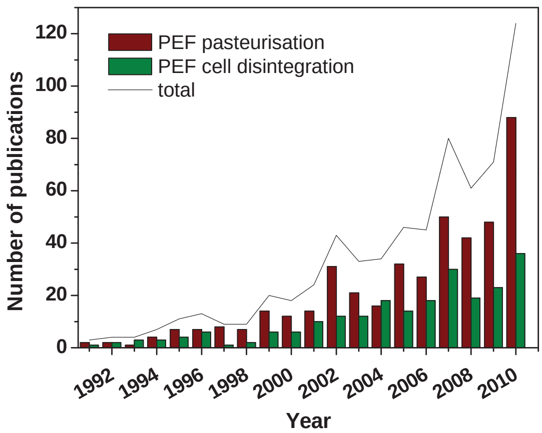




Database: Journal articles listed in Sciencedirect, Springerlink, Taylor&Francis with the following items in abstract, title and keywords: HP pasteurisation, sterilisation, inactivation, enzyme, starch



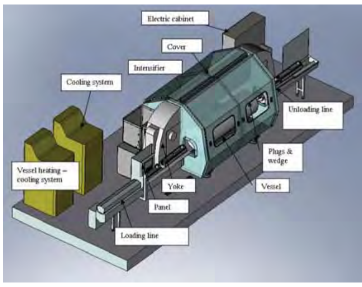
Industrial HPP machines number versus food industries May 2010



Industrial tandem high pressure processing

New NC Hyperbaric i420 equipment installed in Millard Refrigerated, Pennsylvania

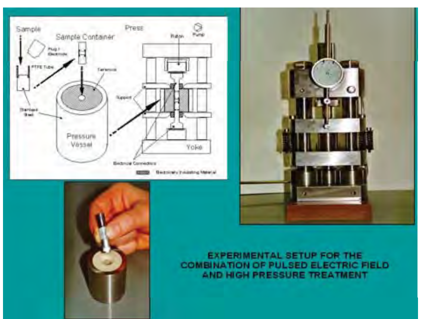
New industrial unit Wave 6000/55HT (Spain)



(Tonello Samson, C., 2008, NC Hyperbaric, Spain, personal communication)

CONCERTED ACTION

EC project HP: 1992- 1996



AIR PROJECT CONTRACT No. AIR 1-CT 92-0296

HIGH HYDROSTATIC PRESSURE TREATMENT; ITS IMPACT ON SPOILAGE ORGANISMS; BIOPOLYMER ACTIVITY; FUNCTIONALITY AND NUTRIENT COMPOSITION OF FOOD SYSTEMS

PROJECT SUMMARY

NOVEMBER 1992 - MAY 1996

Coordinator:
Berlin University of Technology, Dept. of Food Technology **TUB**, Prof. D. Knorr, Königin Luise-Str.22, D-14195 Berlin, Tel :+49 30 314 71250, Fax:+49 30 832 7663, foodtech@mailszrz.zrz.tu-berlin.de

Participants:
Université Montpellier II, Unité de Biochimie et Technologie Alimentaires **BTA**, Prof. J.C. Cheftel, Place Eugene Bataillon, F-34095 Montpellier Cedex B, Fax 33 4 67633397

Rijksuniversiteit Gent, Laboratory of Food Technology, Chemistry and Microbiology **CFTCMUG**, Prof. A. Huyghebaert, Coupure links 653, B-9000 Gent, Fax 32 9 223 3911

Katholike Universiteit Leuven, Laboratory of Chemical and Biological Dynamics, Laboratory of Food Technology **KU LEUVEN**, Prof. M. Hendrickx, Kardinaal Mercierlaan 92, B-3001 Heverlee, Fax 32 16 321997; Prof. K. Heremans, Celestijnenlaan 200 D, Fax 32 16 327982

University of Reading, Department of Chemistry **URDC**, Dr. N. Isaacs, UK-Reading RG 6 , Fax 44 118 931 1610

Unilever Research Laboratories, Vlaardingen **URL VL**, Dr. J. Smelt, Olivier van Noortlaan 120, NL-3130 Vlaardingen, Fax 31 10 4605873

GEC ALSTHOM **ACB**, Dr. J.E. Lebas, 38 Ave. Kleber, F-2x-44040 Nantes Cedex 04, Fax 33 2 40470151

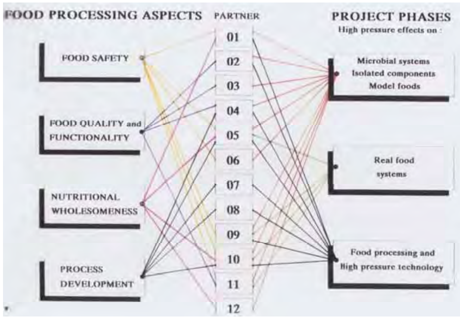
FMC Europe Corp. **FMC**, Dr. B. Mertens, Breedstraat 3, B-9100 Sint Niklaas, Fax 32 3 7777955

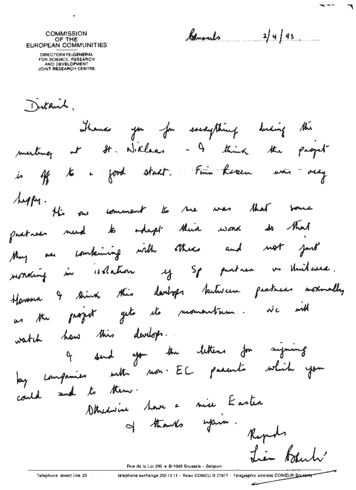
CPC Europe Consumer Foods Ltd. **CPC EUROPE**, Dr. R. Stute, Knorrstr. 1, 74074 Heilbronn, Fax 49 07131 501518

Universität Heidelberg, Physical Chemistry Unit **RKUH**, Prof. H. Ludwig, Im Neuenheimer Feld 346, D-69120 Heidelberg, Fax 49 06221 545475 / Federal Research Institute for Nutrition, Prof. B. Tauscher, Engesserstr. 20, D-76131 Karlsruhe, Fax 49 7216625167

Universidad Autonoma de Barcelona, Food Technology Unit **UAB**, Prof. B. Guamis Lopez, Campus e Bellaterra, E-08193 Barcelona, Fax 34 3 5812006

Institute Francais des Boissons de la Brasserie Maltiere **IFBM**, Dr. P. Boivin, 7 rue du Bois de la Champelle, F-54512 Vandoevre, Fax 33 3 83 44 12 90





COMMISSION OF THE EUROPEAN COMMUNITIES

DIRECTORATE-GENERAL FOR SCIENCE, RESEARCH AND DEVELOPMENT JOINT RESEARCH CENTRE

Brussels 2/4/93

Dietrich,

Thanks you for everything during the meeting at St. Niklaas - I think the project is off to a good start. Finn Rossen was very happy.

His one comment to me was that some partners need to adapt their work so that they are combining with others and not just working in isolation eg Sp partner vs Unilever. However I think this develops between partners normally as the project gets its momentum. We will watch how this develops.

I send you the letters for signing by companies with non-EC parents which you could send to them.

Otherwise have a nice Easter & thanks again.

Regards

Liam Breslin

Rue de la Loi 200 • B-1049 Brussels - Belgium

Telephone: direct line 23 . . . telephone exchange 235 11 11 - Telex COMEU B 21877 - Telegraphic address COMEUR Brussels

Some high pressure units:

Monovessel

Microscope cell

Multivessel

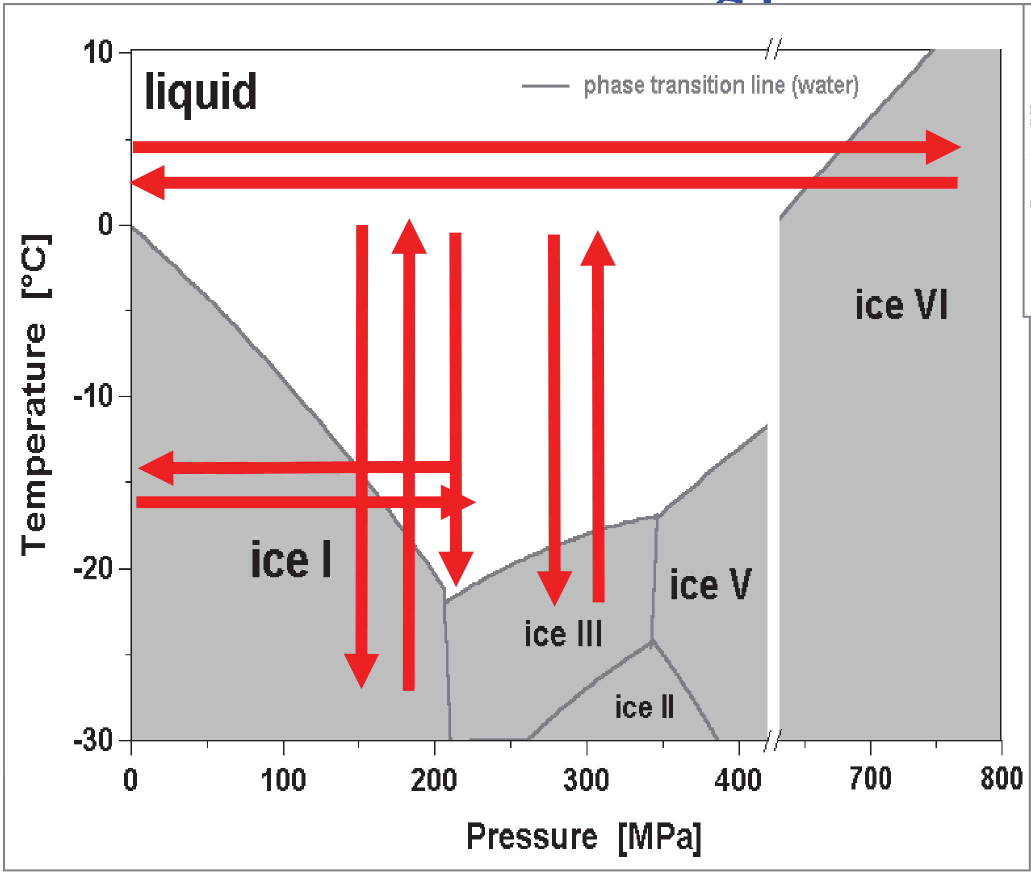
U4000

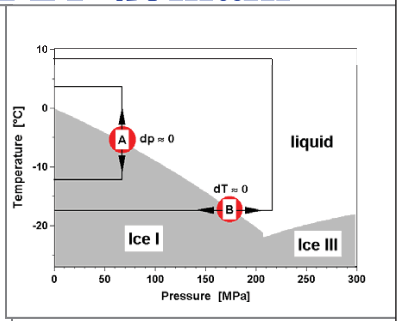
Simonazzi

CONCERTED ACTION

SAFE ICE

Processing paths in HPLT domain



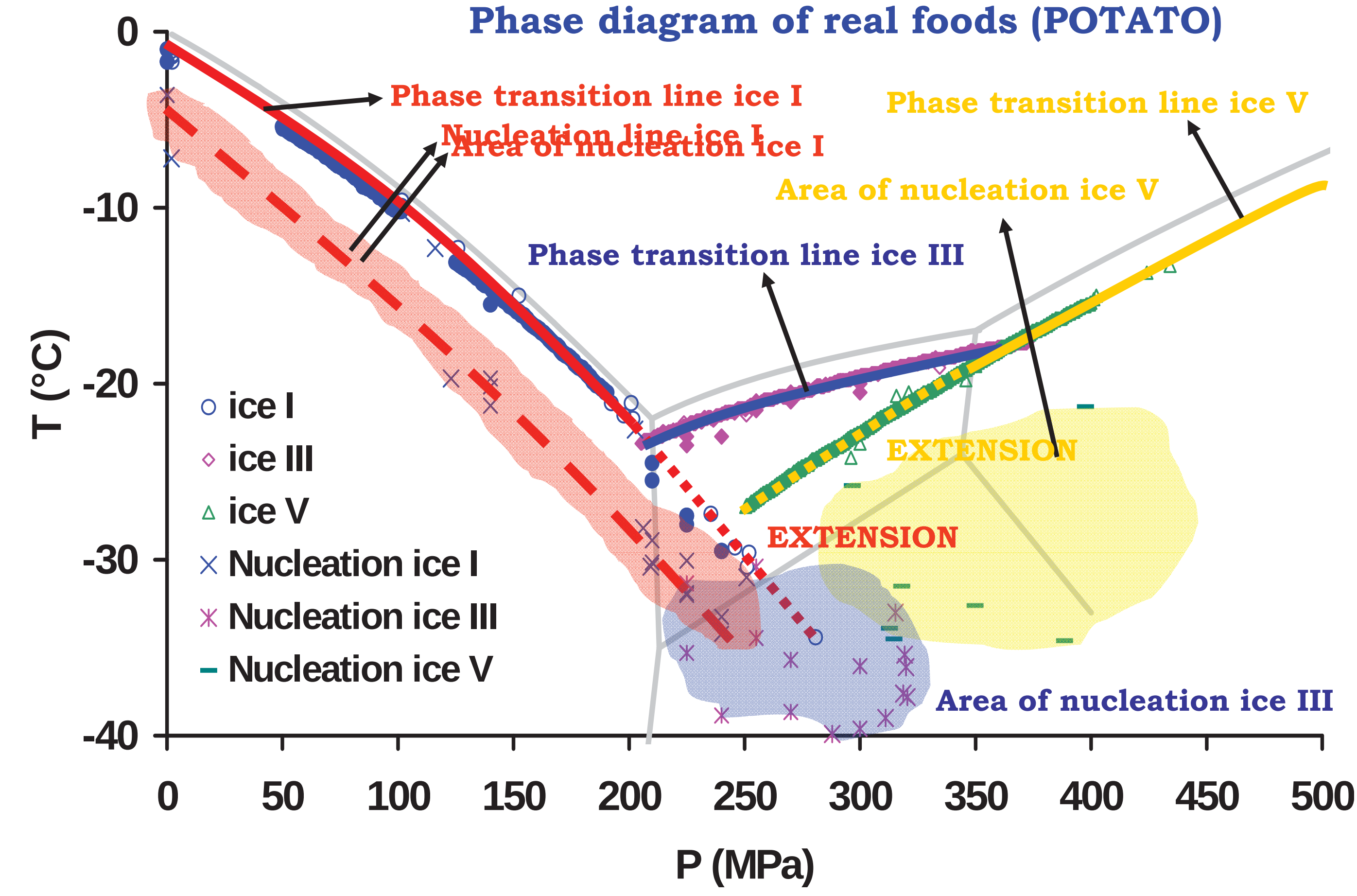


- ➔ Pressure assisted Freezing/thawing
- ➔ Freezing/thawing to ice III, ice V…
- ➔ Storing food < 0 °C
- ➔ Pressure Shift Freezing
- ➔ Pressure Induced Thawing
- ➔ Pressure Induced Freezing > 0 °C
- ➔ Pressure Shift Thawing

SAFE ICE

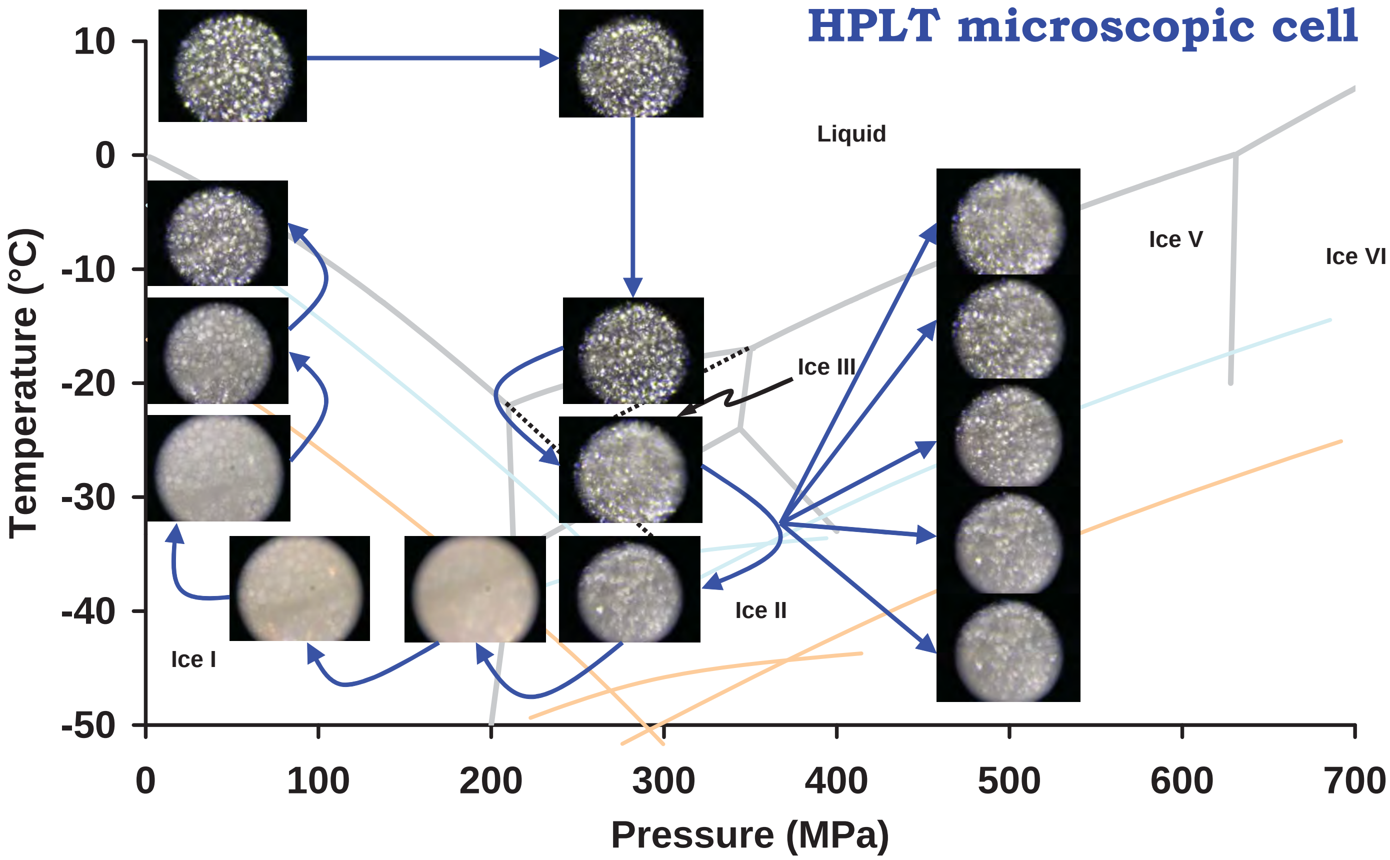
CONCERTED ACTION

Phase diagram of real foods (POTATO)



CONCERTED ACTION

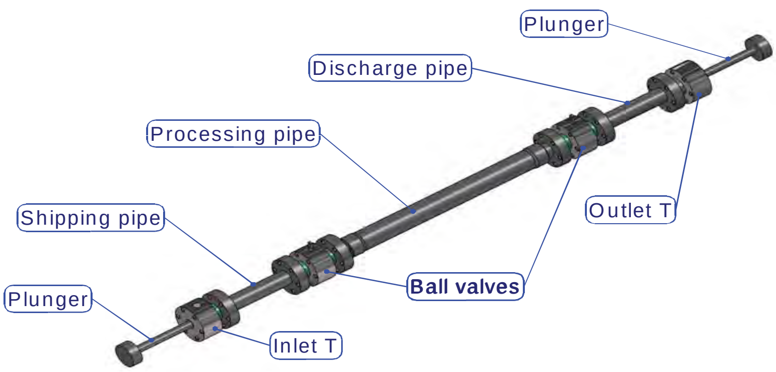
SAFE ICE

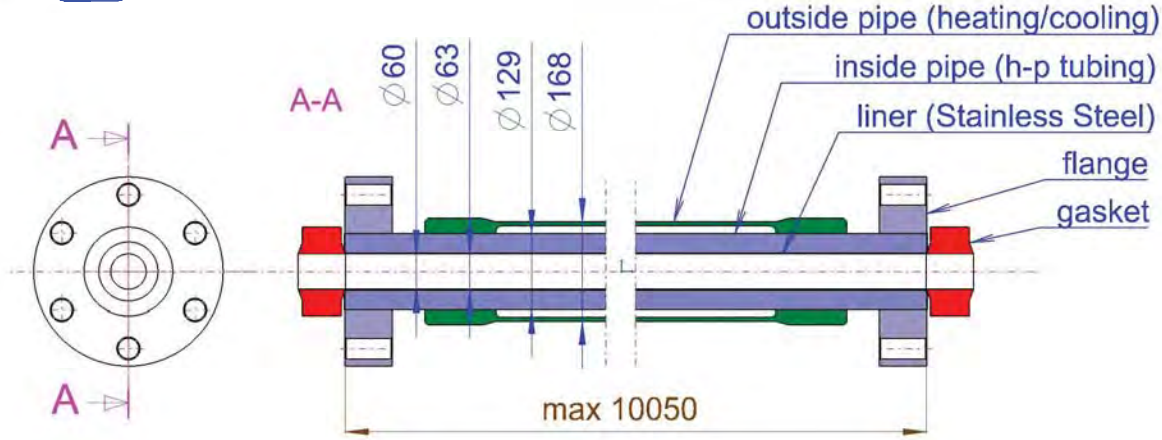


CONCERTED ACTION

SAFE ICE

Industrial process concept development





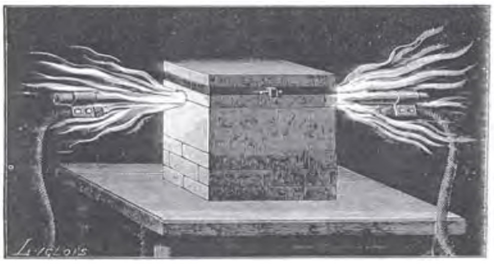
Objectives

The **overall objective** of this proposal is to address and overcome specific scientific and technological hurdles to make an infomed judgement on the relevance of HELP technologies and to identify and to deliver their full benefits. The **general objectives** are:

- to systematically explore the scientific questions relevant to the effects of HELP on the safety and quality of food materials, and
- to use the information generated as the basis for proposing new process options.

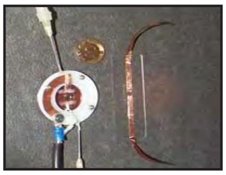
HIGH ELECTRIC FIELD PULSES: FOOD SAFETY, QUALITY, AND CRITICAL PROCESS PARAMETERS

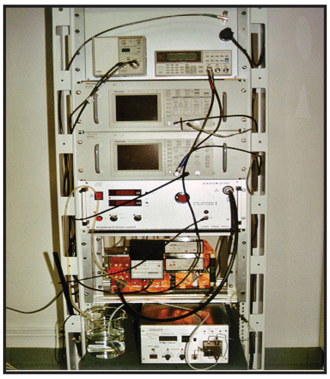
RASO, U. Zaragoza
ALVAREZ, U. Zaragoza



Moissan,H. 1904. The electric furnance. Edward Arnold, London

Pilot Equipment PEF






CONCERTED ACTION

Novel Q

approx 25 PhD students
130 publications
TCD Network

HP Process inhomogenities
PEF Modeling
Packaging
HP- HT
HP Structure engineering
PEF Mechanisms

Science Platform
Industry Platform
95 companies
Consumer Platform

EQUIPMENT MANUFACTURING

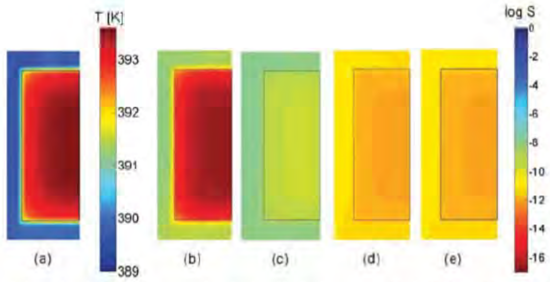
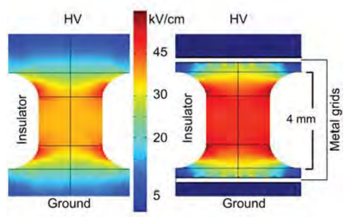


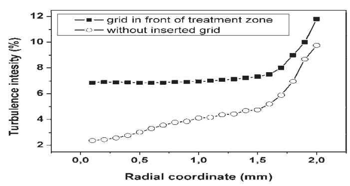
Figure 4. Predicted thermal and *C. botulinum spore* inactivation distribution as seen closely inside package number 4: (a) predicted temperature pattern; (b) inactivation distribution from the log-linear kinetic model A; (c) inactivation distribution from the Weibull model B; (d) inactivation distribution from the *n*th-order kinetic model C; and (e) inactivation distribution from the combined log-linear and *n*th-order kinetic model D.

HP

T, and
P distribution

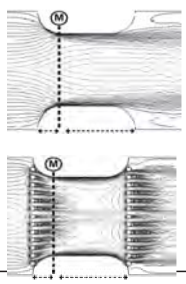
Postitive impact of metall grids on electric field distribution

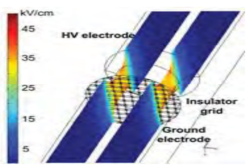




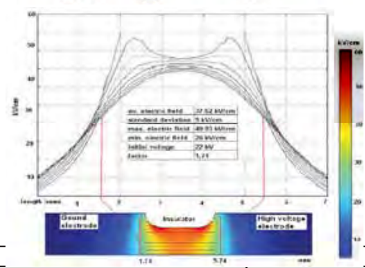
PEF

T, and
E distribution





Icrease of turbulence due to insertion of static mixing devices (grids).



Food Biotechnology and Food Process Engineering

CONSUMER PLATFORM CONSUMER ACCEPTANCE

"…there seems to be good reason for doing further work on the development of PEF and HP, as consumers see potential in these products "

Banati et al.
Boel Nielsen et al. 2009

(1) "Concern": HP: 9% / PEF: 12%
"Uncertainty: HP: 24% / PEF: 41% Cardello, 2003

(2) "High pressure processing was acceptable to the majority of consumers interviewed in France and Germany…" Butz 2003, Fair CT96-1113

(3) "Health professionals hold a positive attitude toward HP, OH and PEF"

Delgardo-Gutiercerrez& Brühn 2008

(4) "As a rule of thumb, the less familiar a technology, the more skeptical people are about it "

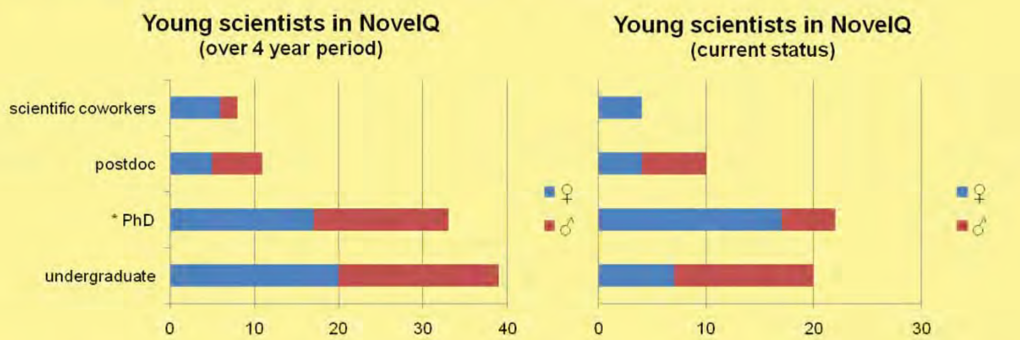
Lyndhurst 2009, FSA

Training and Career Development Network

NovelQ

Training of young scientists

- Research is mainly performed by young scientists (gender equality)
- 9 PhD's have been defended within the NovelQ framework



- Top level research is reflected in award winnings (6)
- Key contributions of SP1 young scientists in TCD (80% of current members)

Sik

TCD Network

1st meeting 2007 state of the art scientific information

2nd meeting 2007 communication and presenting yourself

3rd meeting 2008 communication and presenting yourself

4th meeting 2008 PhD advisory board (science platform)

5th meeting 2009 EFFoST conference Novel Q sessions

6th meeting 2010 European Food Science PhD conference

Awards: Tara Grauwet, KUL: EFFoST/ IFT ("meeting the real dinosaurs in the field…")
Nicolas Meneses, TUB: EFFoST/ IFT

New Novel Q Professors

Inneke Oey, University of Otago

Stephan Töpfl, U. Applied Science, Osnabrück

Albert Baers, U. Applied Science, Bremen

THE FUTURE YOUNG SCIENTISTS

EFFOST, IUFOST

NOVEL Q — TCD Network
PhD conference Berlin

EFCE — PhD workshops
EFFOST — Mentors

THE FUTURE

C Factor (communication)

don´t read (google)
don´t talk (EU proposals)

NEW TOOLS → BLOG- LINKE DIN, FACEBOOK MENTORS

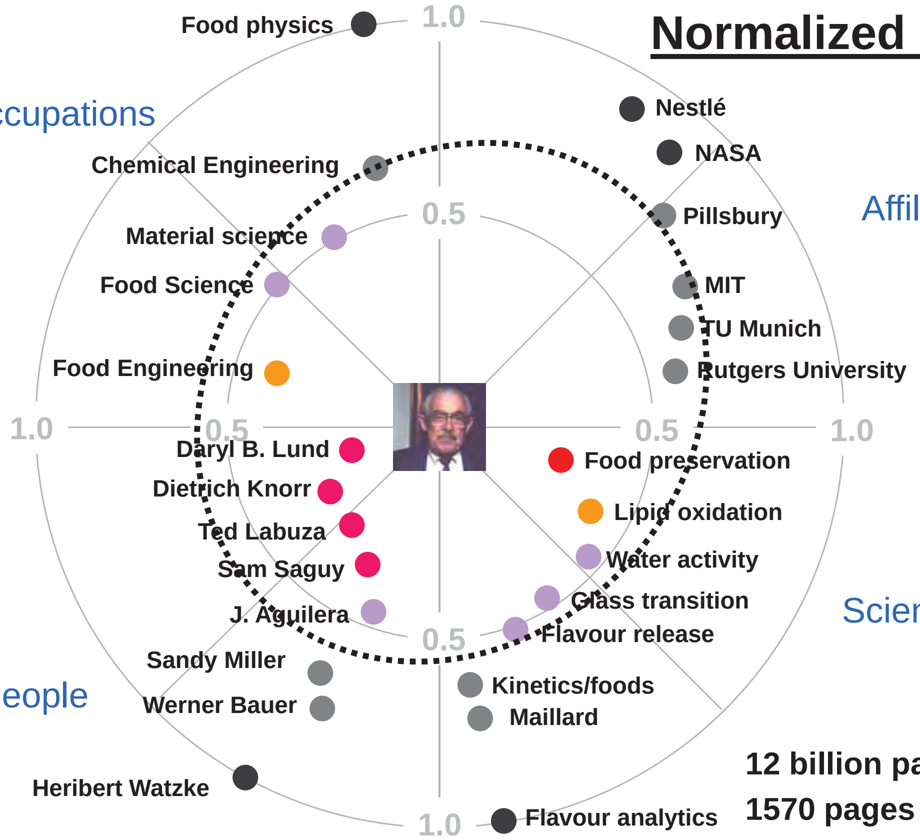
THE FUTURE

N- Factor (Narrowness)

HPHT - HPLT

NEW TOOLS: internet forum
alumni clubs
MENTORS

Googling Marcus



Normalized Google Distance

P. Vitanyi, 2006

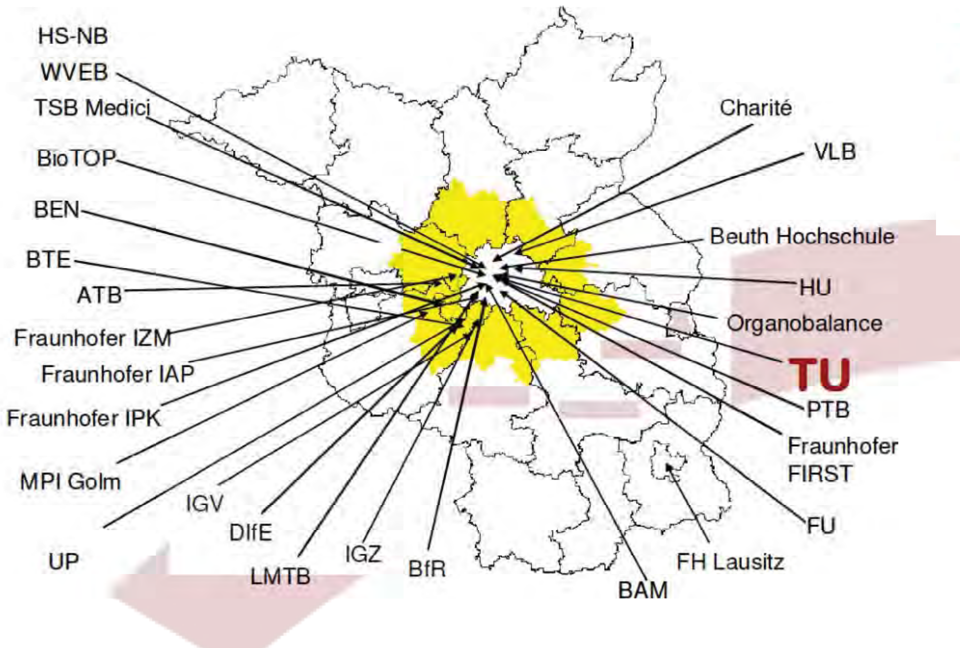
12 billion pages indexed by Google
1570 pages about « Marcus Karel »

Box 8.1 Key priorities for action for policy makers

1. Spread best practice.
2. Invest in new knowledge.
3. Make sustainable food production central in development.
4. Work on the assumption that there is little new land for agriculture.
5. Ensure long-term sustainability of fish stocks.
6. Promote sustainable intensification.
7. Include the environment in food system economics.
8. Reduce waste – both in high- and low-income countries.
9. Improve the evidence base upon which decisions are made and develop metrics to assess progress.
10. Anticipate major issues with water availability for food production.
11. Work to change consumption patterns.
12. Empower citizens.

Participating Institutions

IGE
Innovationszentrum Technologien für Gesundheit & Ernährung
Innovation Center Technologies for Health & Foods
www.IGE.tu-berlin.de

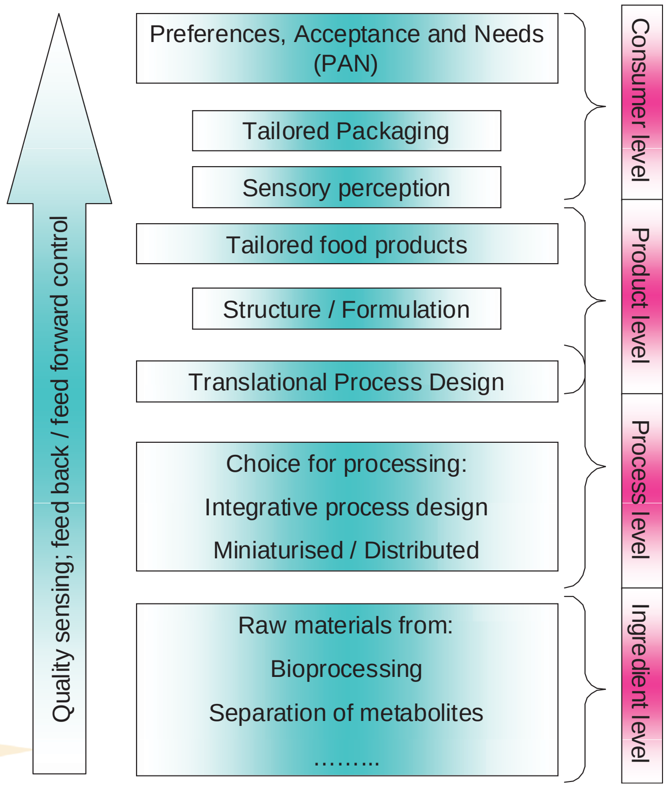


Food Quality & Manufacturing

European Technology Platform Food for Life

Developing quality food products

- Producing tailor-made food products
- Improving process design ,and process control and packaging
- Improving understanding of process-structure-property relationships
- Understanding consumer behaviour in relation to food quality and manufacturing



The European Food Industry today

- Europe's global export market share declined from 24 to 20% over 10 years, making Europe a net importer instead of exporter since 2004.
- The food sector's share of R&D investments is only 1% (rank 15)
  - The pharmaceutical and biotechnology sector is ranked nr 3 with a share of 18%.
- Business expenditure on R&D as a percentage of total output is 0.24%, far below e.g. Japan (1.2%).

  Therefore, "a radical change in the policies related to research, development and innovation in the food sector is needed in Europe"

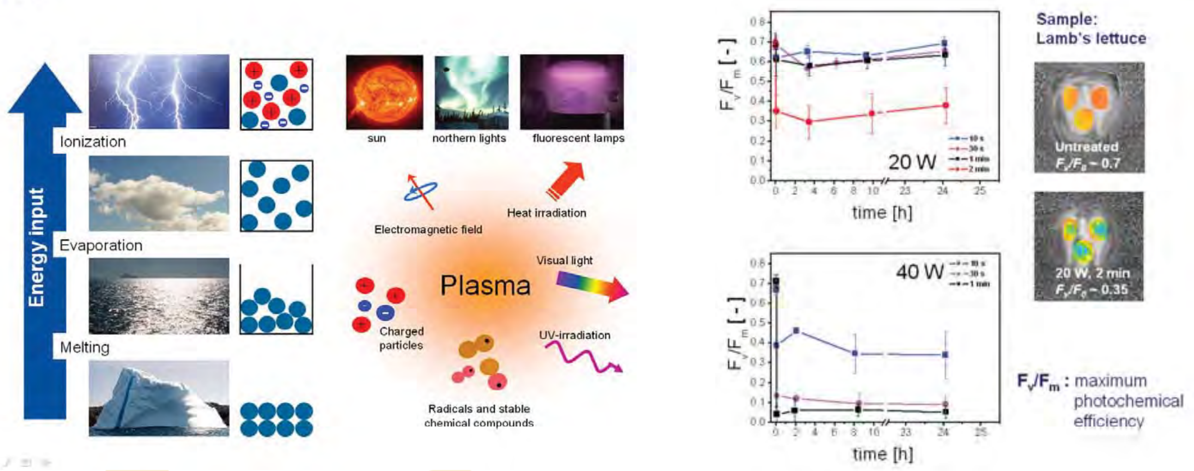
Research Agenda

- The most important issues for policy makers in the coming decades are:
  - cross sector activities like food-technology, food-transport, and food-health.
  - At the interface of sectors, advances will be achieved.
  - R&D intensity is substantially higher in sectors outside the food domain.
- Policy makers should emphasize the competitive role of Europe in world food systems.
  - The rich and diverse European Cuisine;
  - Cultural differences in Europe;
  - Europe as a global cultural playing ground for development of new food concepts (e.g. food concepts for and tested by the Indian, Chinese, Brazilian, etc consumer groups);
  - The leading role in sustainable

CHALLENGES / OPPORTUNITIES

- **HYGIENE / SAFETY**
- **ROBUST / SCALABLE TECHNOLOGIES**
- **AUTOMATION / ROBOTICS / SENSORS**
- **NEW TECHNOLOGIES / TECHNOLOGY TRANSFER**
- **COMBINATION PROCESSES**
- **UNDERSTANDING NEW TECHNOLOGIES**
- **PROCESS INTEGRATION**
- **SUSTAINABILITY & TRANSPARENCY**

Introduction
Plasma



TRANS DANUBEAN CONFERENCE ON WATER AND FOOD SAFETY

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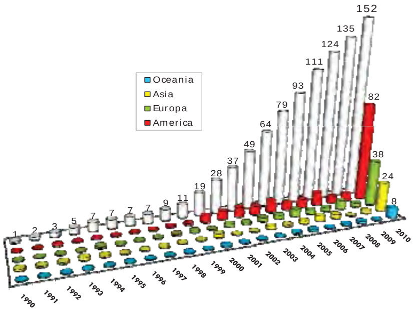
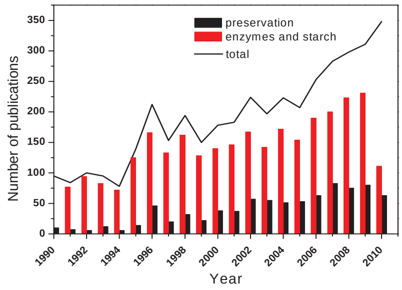
Anne Grohmann
Dieter Oberdörfer

Katharina Schössler
Daniel Baier
Irina Smetanska
Nicolas Meneses
Anna Janositz

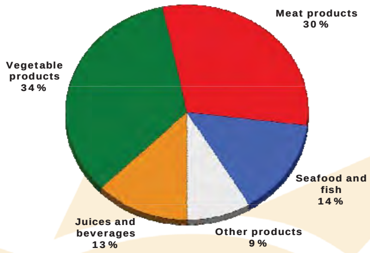
Evolution of HPP industrial machines installed on continents

May 2010

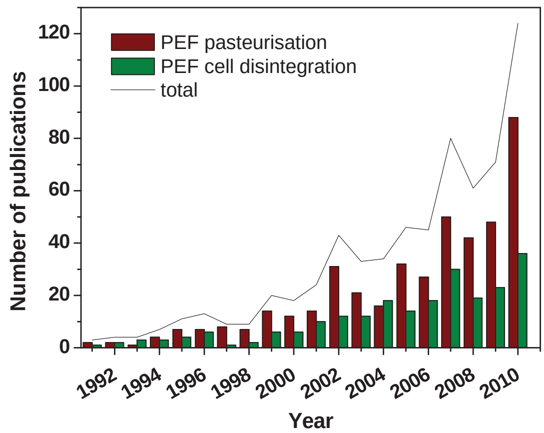


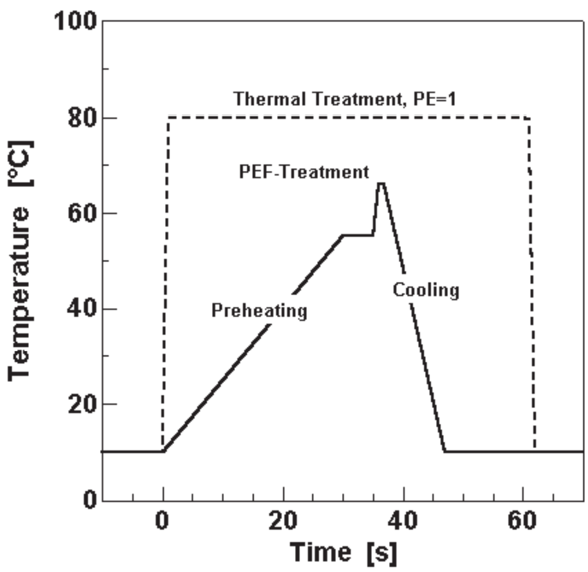


Database: Journal articles listed in Sciencedirect, Springerlink, Taylor&Francis with the following items in abstract, title and keywords: HP pasteurisation, sterilisation, inactivation, enzyme, starch



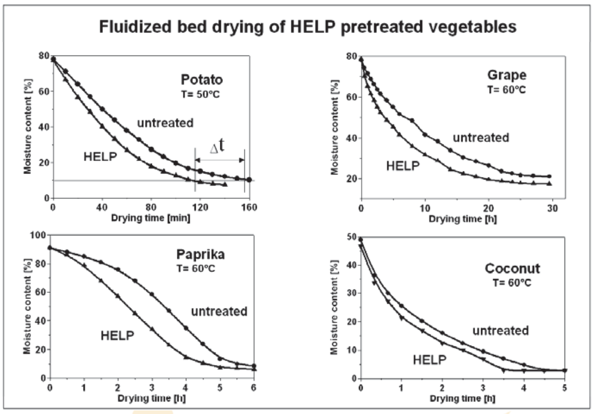
Industrial HPP machines number versus food industries May 2010

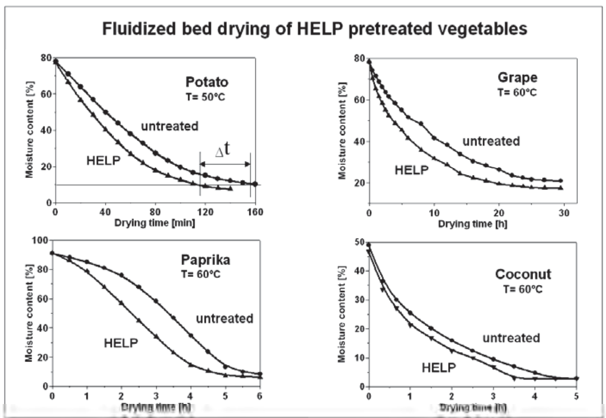




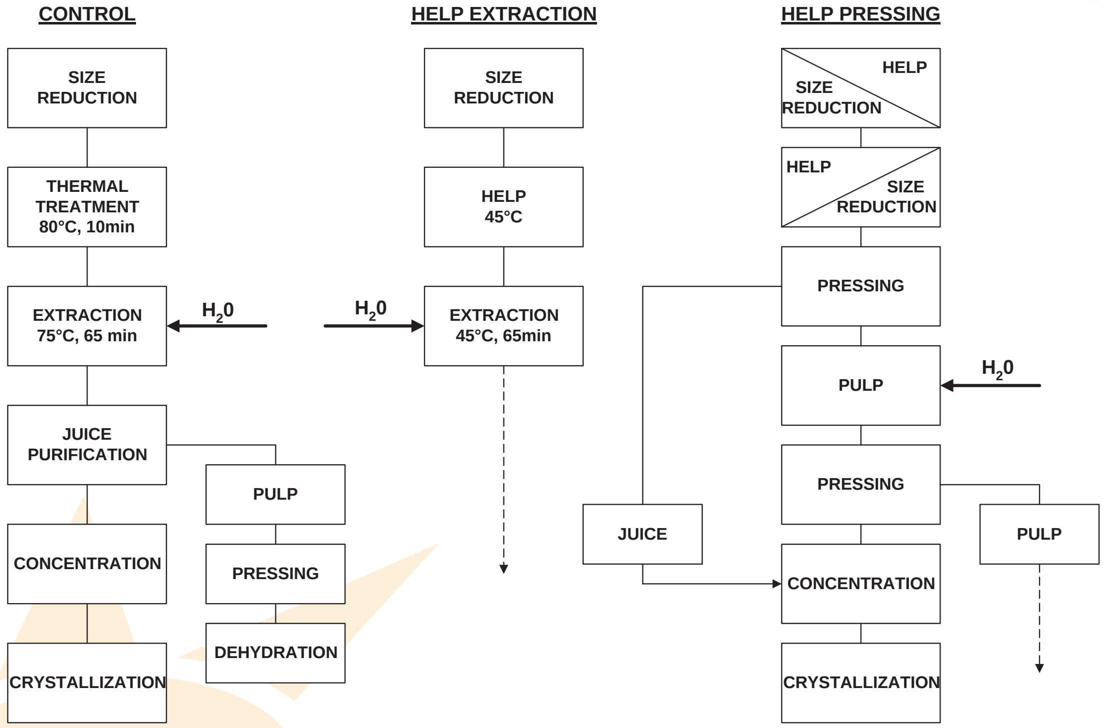
Temperature-time-profile of PEF-treatment of Apple Juice with an inlet temperature of 55°C and a specific energy input of 40kJ/kg comparded to a thermal treatment with the effect of one pasteurisation unit (PE).

Methods of pre-treatment of coconut milk (15 MPa, 10 min)	Protein content (%)	Fat Content (%)	Milk yield (%)	Cell disintegration index
Freezing-thawing	52.50	62.40	63.50	1.00
Mechanical disruption(control, finely grated)	51.60	61.20	50.00	0.90
Mechanical disruption(control,coarsly grated)	45.90	60.00	42.50	0.70
HELP process	50.00	58.00	60.00	0.75
Thermal treatment (70 °C held for 15 min)	36.30	59.50	53.00	0.73



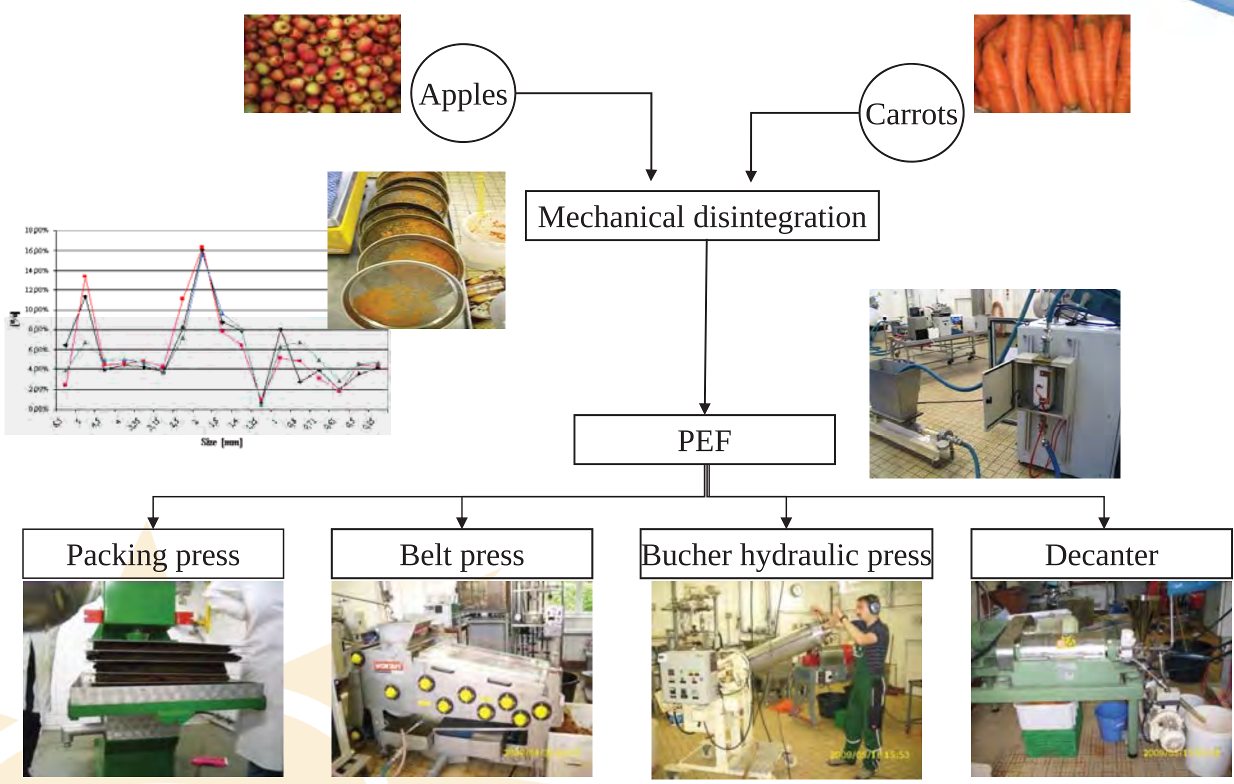


SUGAR BEET JUICE EXTRACTION



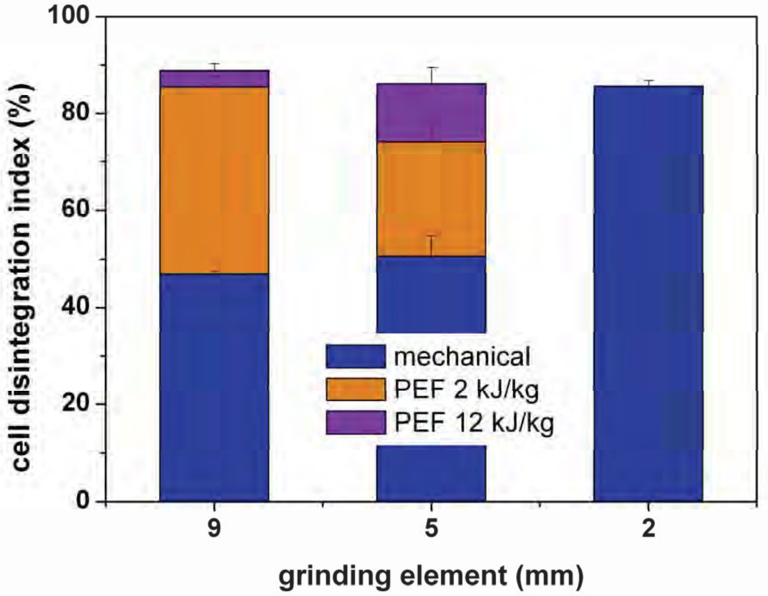
Process integration

PEF and juice production – adaptation of processing steps



PROCESS INTEGRATION

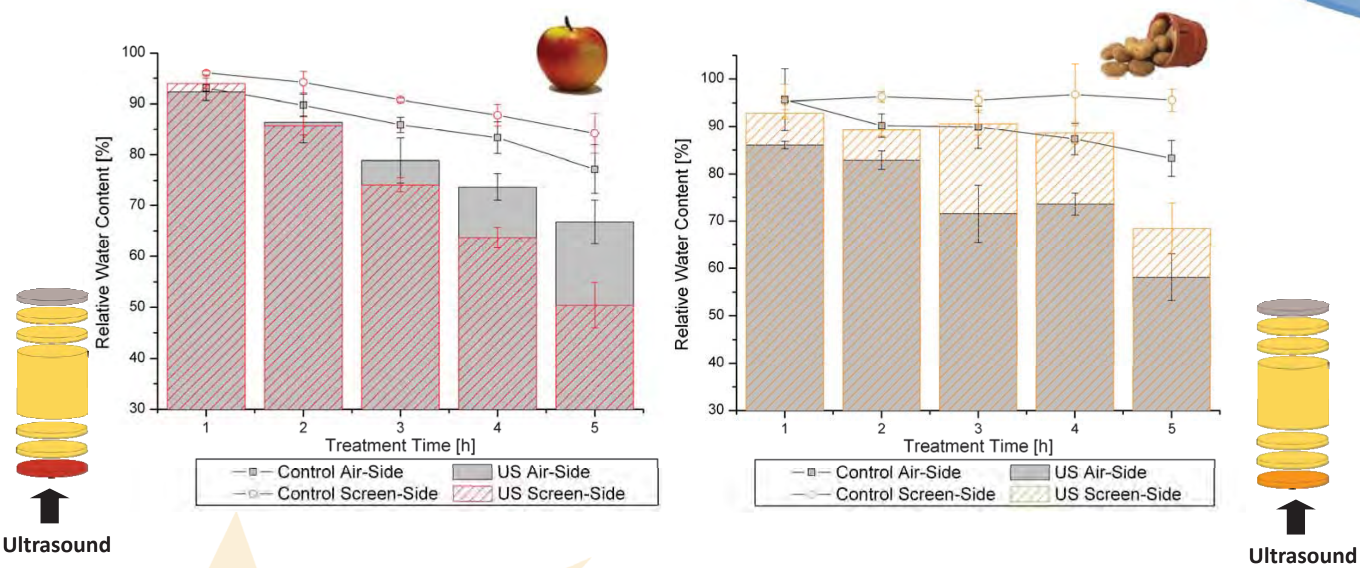
Cell disintegration index



No mechanical disintegration without changing of particle size

Electroporation: disintegration and particle size are independent

Influence on water transfer



- Although visible cell damage limited to ~ 1 mm, water transfer is influenced in samples of 1 cm thickness
- Vibration effects more important than cell damage
- Improved evaporation at sonicated side

Non-thermal atmospheric plasma jet

Inactivation of bacteria and enzymes

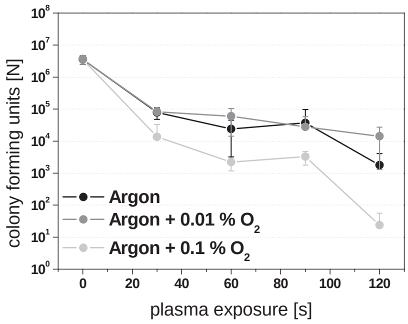


Fig 1. Inactivation of *E.coli*

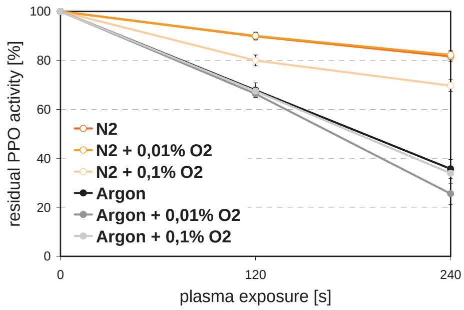


Fig 2. Inactivation of PPO in non pasteurized apple juice

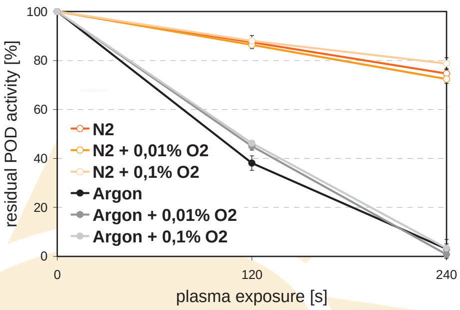


Fig 3. Inactivation of POD in non pasteurized apple juice

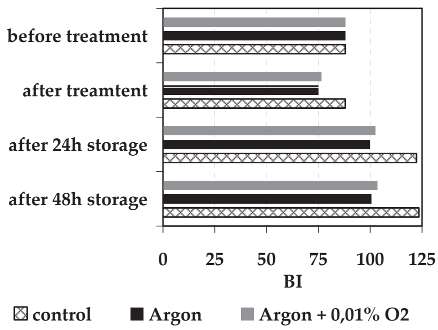
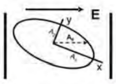
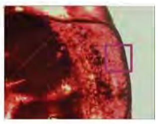


Fig 4. Impact of plasma treatment on browning index (BI) of non pasteurized apple juice

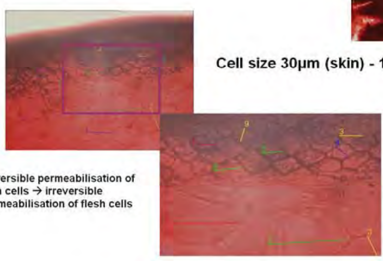
PROCESS- STRUCTURE- FUNCTION

Stress induction – cell size





Cell size 30µm (skin) - 140µm (flesh)



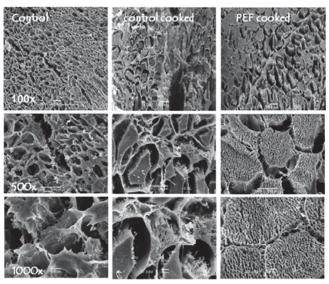
Reversible permeabilisation of skin cells → irreversible permeabilisation of flesh cells

PEF Treatment of Meat Products – REM Micrographs

Improvement of water binding indicated by swollen, sponge-like tissue structure

Improved micro-diffusion of brine

Improved water binding due to interaction between protein/salt/phosphate



Change of meat after 1 min at 0.1-600 MPa and 25°C

PROCESS- STRUCTURE- FUNCTION

PHYSICAL MODIFICATION OF PREBIOTICS

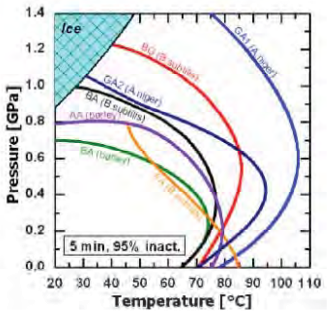
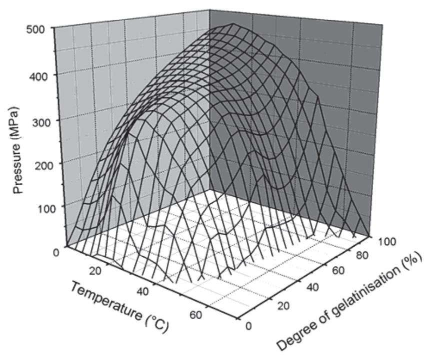
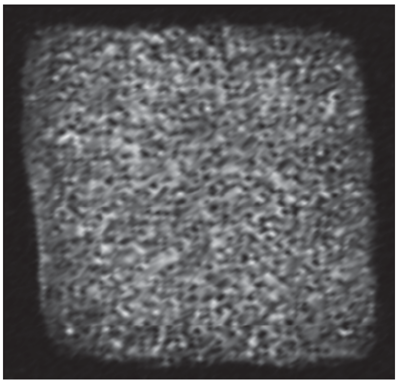


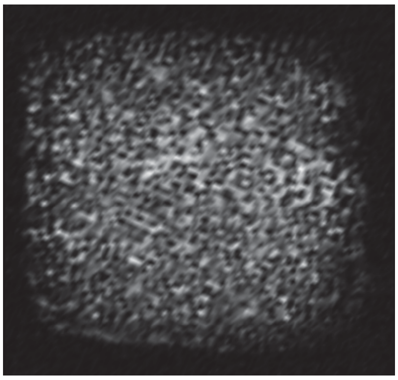
Abb.3: Druck-Temperatur-Isokinetik-Diagramm für 95% Inaktivierung von β-Amylase (Gerstenmalz) in 0.1M ACES Puffer (pH 5.6), α-Amylase (Gerstenmalz) in 0.1M ACES Puffer + 3.8 mM CaCl2 (pH , 5.6), β-Amylase (*B. subtilis*) in 0.05M ACES Pufferlösung (pH 6.3), α-amylase (*B.subtilis*) in 10mM Tris-HCl Puffer (pH 8.6), β-Glucanase (*B.subtilis*) in 0.05M ACES buffer (pH 5.6), und Glucoamylase 1 und 2 (*A.niger*) in 0.05M ACES buffer (pH 4.5) nach 5 min Behandlungszeit.

P,T-3D map of starch gelatinization



PROCESS- STRUCTURE- FUNCTION





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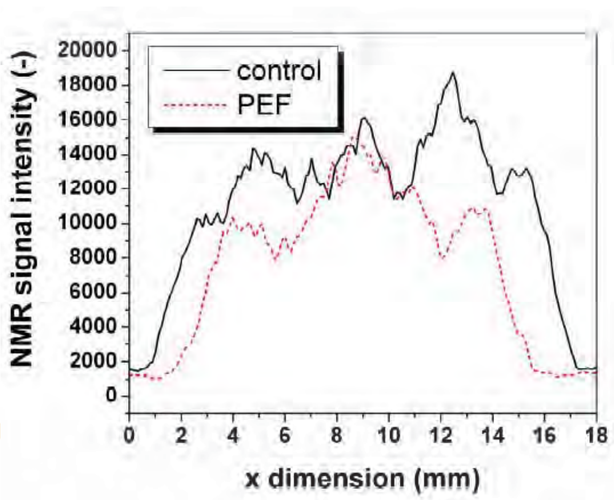

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PROCESS- STRUCTURE- FUNCTION

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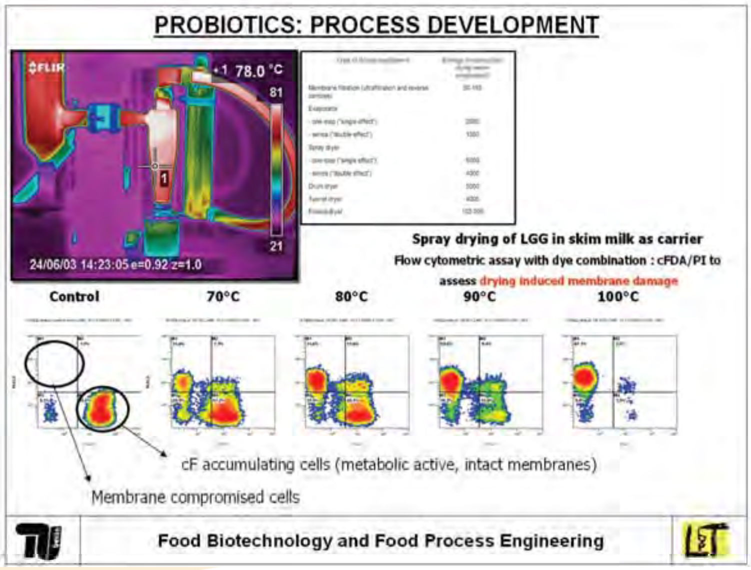
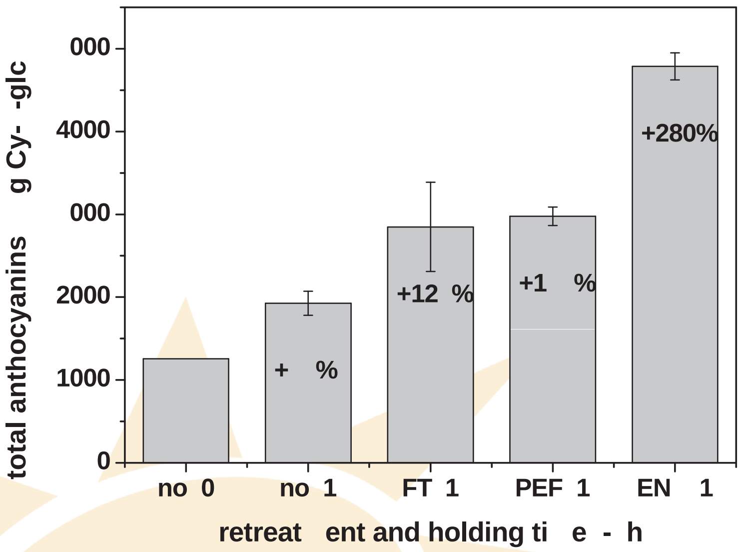


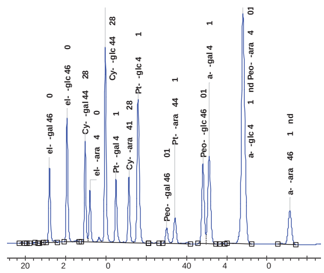
Food Biotechnology and Food Process Engineering

TAI OR A E FOO CONCEPTS

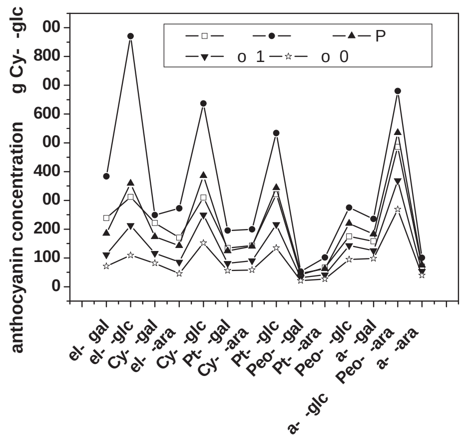
Selective extraction

Blueberry mash pretreatment and anthocyanin content and profile in the juice





(FT FreezeThawing -10 C, 2x2h;
PEF 4 kV/cm, 30 kJ/kg;
Maceration temperature 45 C)

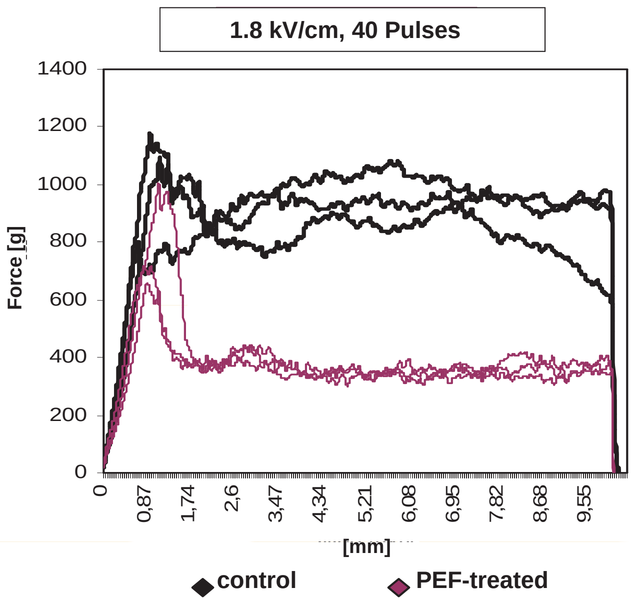


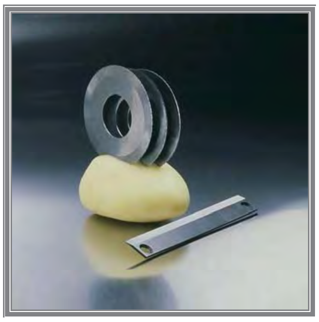
ymatic maceratio promotes release o speci ic a t ocya i s

TAI OR A E FOO CONCEPTS

Cell disintegration or tiss e so tening and red ction o c tting energy

Disintegration of potato tissue

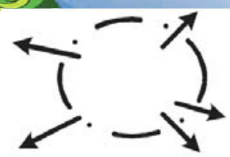




Influence of PEF treatment on the texture of potato tissue (cutting force)

TAILOR MADE FOOD CONCEPTS

PEF cell permeabilisation

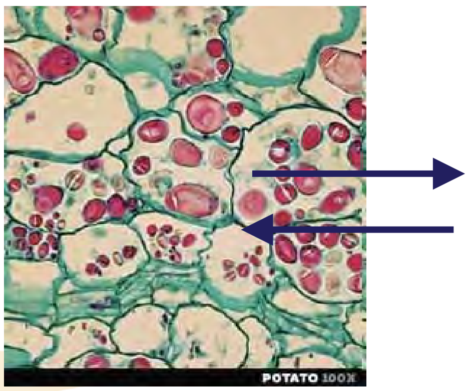


- cleaning
- peeling
- cutting
- blanching
- frying
- freezing

Concepts:

- Increased release of sugars during blanching
- Increased infusion of glucose oxidase followed by enzymatic conversion of glucose

→ **Removal of substrates**



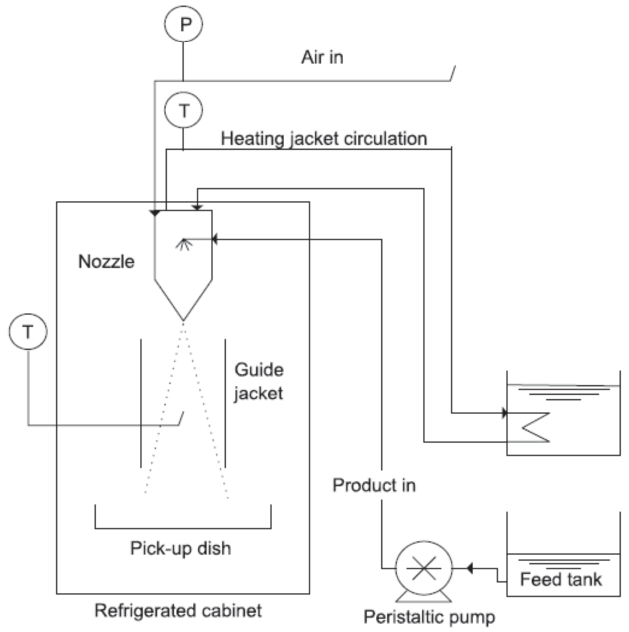
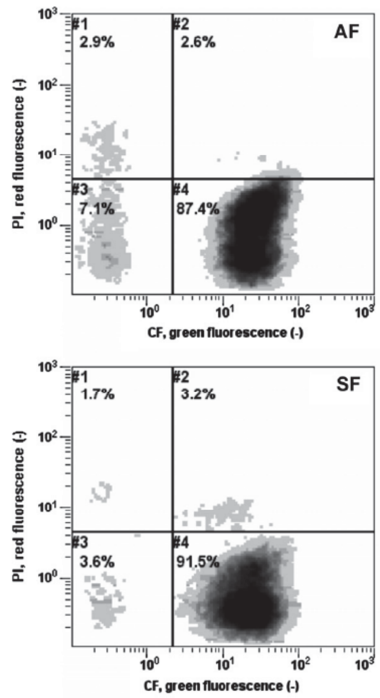


Fig. 1. Schematic drawing of the spray freezing unit.



M. Volkert et al. / Journal of Food Engineering 87 (2008) 532–540