



Project No. **023140**

Project acronym: **HighQ RTE**

Project full name: **INNOVATIVE NON THERMAL PROCESSING TECHNOLOGIES TO IMPROVE THE QUALITY AND SAFETY OF READY-TO-EAT (RTE) MEALS**

Instrument type: Specific Targeted Research Projects

Priority name: Food Quality and Safety

Publishable Executive Summary

Periodic Management Report

Periodic Funding Distribution Report

Publishable Final Activity Report

Final plan for using and disseminating the technology

Final Management Report

Final Funding Distribution Report

Period covered: 01/10/2007 to 30/09/2008

Date of preparation: 14/11/2008

Start date of project: 01/10/2006

Duration: 36 months

Project coordinator organisation name: University of Bologna – Dipartimento di Scienze degli Alimenti

Project coordinator name: Prof. Elisabetta Guerzoni

Publishable Executive Summary



HighQ RTE

“INNOVATIVE NON THERMAL PROCESSING TECHNOLOGIES TO IMPROVE THE QUALITY AND SAFETY OF READY-TO-EAT (RTE) MEALS”

Project objectives

The project **HighQ RTE** aims to improve the safety and quality of three representative categories of European ready-to-eat foods: ready-to-eat salads, fluid foods, and ready-to-eat vegetable based meals.

In fact several papers reported that European ready-to-eat foods, and particularly Refrigerated Processed Foods of Extended Durability (REFPEDs), are frequently contaminated with pathogenic species. In order to enhance the safety of the three categories of foods, and at the same time prevent the heat-induced physicochemical and nutritional changes, non-thermal novel processes will be developed and applied.

For **ready-to-eat vegetable and fruit salads**, procedures based on Photosensitization (**PHOTO**) will be set up in WP1 in order to drastically reduce the contamination level of naturally occurring and inoculated pathogenic species in vegetable raw materials and packaging.

For **fluid foods**, Pulsed Electric Fields technologies (**PEF**) and semi-continuous High Pressure Homogenization (**HPH**) will be compared in WP2 and WP3, respectively both in terms of pathogenic species inactivation, microbiological quality and changes of the properties of proteins as well as food microstructure and rheology. The ability of the latter technology to activate naturally occurring or exogenous enzymes will be exploited in order to generate new bioactive natural food components.

For **ready-to-eat meals** of vegetable origin High Hydrostatic Pressure will be applied to meals packaged under CO₂ atmosphere (**HHPCO**) in comparison and in addition to traditional mild heat processes (WP4).

The optimisation of the formulation of the fluid or solid food systems to be subjected to the various technologies will be performed taking into consideration nutritional aspects (salt, lipid contents), the possible physicochemical and structural changes induced by the processes and the specific requirements of the various process technologies (PHOTO, PEF, HPH, HHPCO) in terms of physical state and rheology (appropriate viscosity, particles presence and size etc). For the various combinations products-processes also the optimisation of the formulation of the meals will be performed in relation to chemical, nutritional, microstructural and functional changes induced by the exposure to the various processes.

For each technology, (i) inactivation due to the different treatments; (ii) re-growth of inoculated pathogens during storage; and (iii) growth of indigenous flora will be modelled. The developed deterministic and probabilistic models will be integrated into quantitative risk assessment procedures in order to determine the parameters of the different treatments necessary to obtain the desired shelf-life and quality level of food with the various technologies.

Contractors involved

Organisation name	Short name	Country	Person in charge
University of Bologna - Dipartimento di Scienze degli Alimenti	UNIBO	Italy	M.Elisabetta Guerzoni
CAMST	CAMST	Italy	Pasquale Saracino
Vilnius University - Institute of Material Sciences and Applied Research	VU	Lithuania	ZivileLuksiene
Universitat Politècnica de València	UPV	Spain	Isabel Pérez Munuera
SIK - Institutet for Livsmedel och Bioteknik AB	SIK	Sweden	Elisabeth Borch
Institute of Food Research	IFR	United Kingdom	Jozsef Baranyi
Laboratoire National de Métrologie et d'Essais	LNE	France	Catherine Loriot
Consejo Superior de Investigaciones Científicas	CSIC	Spain	M. Pilar Cano
UAB "Palink"	UAB	Lithuania	Modestas Keblys
Tecnoalimenti S.C.p.A.	TCA	Italy	Marco Gerevini
Ortoreale S.r.l.	ORT	Italy	Paola Massari
Cooperativa Sociale "Il Bettolino" S.C	CSB	Italy	Katia Verzellesi
Rubinetteria Webert S.r.l.	WEB	Italy	Emanuele Zanetta
Acetum s.r.l.	ACE	Italy	Cesare Mazzetti
Centro Tecnico Regionale di Ricerca sul Consumo Europeo	CTRRCE	Italy	Marino Melissano

Work performed and results achieved so far

During the **second year of the project** many research activities were successfully carried out. Major scientific achievements of the project's Workpackages (WPs) are:

WP1 - Photosensitization-based inactivation of three food pathogens (*S. enterica*, *B. cereus*, *L. monocytogenes*) was determined using different photosensitizers. For instance, 4-6 log inactivation of *Salmonella*, *Listeria* and *Bacillus* was achieved by ALA-based photosensitization *in vitro*. Protocol of inactivation conditions (including critical factors such as density of bacteria, incubation with ALA time, accumulation of photosensitizer in the cell, irradiation time, light density) has also been obtained. Decontamination of packaging material by ALA-based photosensitization from these pathogens was effective and reached 4-6 log, while superficial decontamination of food matrix from the target pathogens by ALA-based photosensitization was less effective (1-1.5 log). Hypericin was a very effective photosensitizer *in vitro* (6 log reduction), but it induced only a < 1 log reduction of *B. cereus* in fruit matrix. Also Chl-Na- salt was effective when used as photosensitizer *in vitro* (7 log inactivation for *B. cereus* and *L. monocytogenes*, but only 2 log for *Salmonella*) and with packaging material particularly towards *B. cereus* and *L. monocytogenes* (3-4.5 log). No physical or chemical changes in packaging material were detected after photosensitization treatment.

WP 2 - In order to achieve a reasonable reduction of *L. monocytogenes* and a product outlet temperature below 50°C, repeated **PEF** treatments with cooling in-between were applied. Inactivation of *L. monocytogenes* with up to 4 log CFU was achieved. Another way of obtaining a satisfactory bacterial reduction was to apply a mild heat treatment subsequent to the PEF treatment. The evaluation was mainly been done in phosphate buffer but also in milk and whole eggs. The effect on reduction of *L. monocytogenes* by PEF treatment of milk was better than in phosphate buffer. The time for *L. monocytogenes* to grow to a certain level after PEF treatment was increased by adding potassium sorbate. The evaluation was made in phosphate buffer. Microstructural results showed a highly affected lipoprotein matrix in whole liquid egg treated by PEF. The continuity of the protein network was broken and some protein granules from the yolk were degraded, especially when high field strength was applied. However, in pasteurised samples a reinforcement of protein-protein interactions was observed. The whole egg homogenization produced a protein granules aggregation and the protein-protein interactions in the lipoprotein matrix were reinforced. Viscosity, colour and textural profiles values were unaffected by the PEF treatment in whole egg samples, but in PEF treated samples, the foam stability was higher than after pasteurization. However, a lower stability of food systems based on a gel structure, as liquid whole egg, would be predictable after PEF treatments, specially when high field strength are used.

WP 3 – The effects of **HPH** treatments, applied with a laboratory scale equipment able to work up to 150 MPa and equipped with a PS valve, were evaluated on simple food such as milk, raw whole eggs inoculated with *L. monocytogenes* or *S. enteritidis* and fruit juices inoculated with spoilage yeasts. A 5 log CFU/ml reduction for *S. enteritidis* in whole liquid egg and raw milk was observed by repeating the treatment at 100 MPa 5 times. 8 repeated HPH treatments at 100 MPa were necessary to reduce 4.5 log CFU/ml *Listeria monocytogenes* in milk. Vegetative cells of *B. cereus* inoculated in milk and processed at 50, 100 and 150 MPa with an inlet temperature of 10 and 30°C showed that an inactivation of 2.5 log CF/ml was obtained by using 100 and 150 MPa when the inlet temperature was 30°C. The inlet temperature presented a synergistic effect on pressure inactivation. In order to enhance the effectiveness of HPH without repeated treatments, 2 different valves (R and PS) were compared using *E. coli* and *Ps. fluorescens* inoculated in milk. The R valve was remarkably more effective than the PS and enabled the elimination or reduction of repeated treatments also when the pressure was 100 or 150 MPa. The use of a more powerful equipment (up to 400 MPa) and pressure exceeding 200 MPa allowed the reduction of 4 log CFU/ml of *Ps. fluorescens* and prevented its recover or growth over refrigerated storage.

WP 4 - LNE has finished the study on the effect of HPP on two different packaging materials (cups and doypacks). Regarding shelf-life of **HHPCO** products, the studies on the behaviour of endogenous microorganisms (total mesophilic bacteria counts, psychrophilic bacteria counts and yeast and moulds counts) and inoculated microorganism (*Listeria innocua*) during refrigerated storage (4 °C) of HHPCO-treated products have been carried out. The survival and recovery abilities of *Listeria innocua* inoculated in the vegetable product (grilled) during storage at 4°C have been evaluated. Also data about the effect on food enzyme activities of HP processing combined with different packaging (vacuum, air, CO₂) were obtained for different vegetables (carrot, zucchini, eggplant, red bell pepper). Chilled storage effects on enzymes of raw pre-cut red bell pepper were achieved. The statistical analysis of the data of *Listeria innocua* inactivation in carrot, raw and grilled red bell pepper and in different packaging (vacuum, air and 95% CO₂) obtained based on a Response Surface Methodology design have been finished. These 200 data of *Listeria innocua* inactivation in carrot, raw and grilled red bell pepper and in different packaging (vacuum, air and 95% CO₂) were formatted according to the ComBase database in collaboration with WP6 (IFR). Data were formatted as inactivation curves and the inactivation kinetics obtained were linear (in log scale). D values calculated did not depend on the type of vegetable and the type of atmosphere in the packaging.

WP 5 - Protocols for FISH and NASBA techniques to detect *Listeria monocytogenes* have been developed. However, both of them resulted to be not applicable in food systems due to their low sensitivity. Moreover, the effects of PEF, heat or HPH treatments on the expression of the genes *rpoB*, *gadA* and *opuCA* has been evaluated evidencing a different repression or activation extent of the target genes in relation to the technology and the process conditions adopted.

WP 6 – During the 2nd year of the project, IFR consolidated and refined the project database, enhanced its capability and populated it with new records on inactivation by the four studied technologies. A new database was also started on re-growth after inactivation. The format of the databases became more sophisticated inasmuch records on inactivation and subsequent re-growth was linked. This makes it possible to study and model the effect of treatment on the re-growth kinetics. Three IFR scientists visited three partners and held training seminars on data computerisation and experimental design. Inactivation models were developed for the different techniques and the most important inactivation parameters were identified. This was complemented by a literature survey from which additional data were included in the database.

WP 7 - A pamphlet to be used for the dissemination of the project has been prepared and printed. Some of the results of the research activities have been presented during international Conferences both as oral or poster presentations and several manuscripts have been accepted for publication on international journals. Moreover a questionnaire to be circulated among the consumers to find out their opinion on the new technologies has been prepared.

WP 8 – Although WP8 was not planned to be active during the 2nd year, some preliminary activities have been carried out in order to initiate contacts and discussion with companies and define the standard references in order to validate the efficacy of innovative treatments. tests

WP 9 - The main activities carried out have been related to the organization of the annual meeting in Gothenburg and a joint meeting with other UC-funded project representatives, the preparation of the documents relative to the project management to be presented during such meeting, the preparation of the documents relative to the midterm review and second reporting period and monitoring the advancement of the project.

Co-ordinator details

University of Bologna - Department of Food Science (<http://www.disa.unibo.it>)

Professor M. Elisabetta Guerzoni

elisabetta.guerzoni@unibo.it

Tel: +39 051 209 65 73

Fax: +39 051 209 65 74

Project web-site

<http://www.highqrte.eu/>