General information	
PPS number	**AF12148**
Title	**PPS Mild preservation**
Topsector and innovation theme	Topsector Agri & Food, Roadmap High quality products
Research organisation	Wageningen Food & Biobased Research
Project manager (research)	Ariette Matser (Wageningen Food & Biobased Research, ariette.matser@wur.nl)
PPS coordinator (on behalf of private partners)	Sander Wierenga (Hoogesteger Fresh Specialists BV)
Contact person (government)	Cor Wever, Ministry of Economic Affairs, department ANK
Start date	1 January 2013
End date	31 December 2017
Short description	The aim of the PPS mild preservation is to deliver added value for the food and technology sector by further development of mild preservation methods and to make these technologies available for a larger group of end users resulting in an increase in quality, shelf life, sustainability and safety of food. Increase in the fundamental and applied knowledge of novel processing plays a key role in this project. This knowledge is used to reduce implementation risks (technological, chemical and microbial safety, consumer acceptance) and to create innovations in safe and sustainable food systems with high added value.

Approval consortium	
The PPS coordinator on behalf of the private partners	X Approved □ Not approved
Remarks	**-**

Planning and progress (please explain any changes with respect to the original project plan)	
Were there any changes in the consortium/ project partners?	In 2014, four new partners joined the consortium: FrieslandCampina, Foodcase, Multivac and Uhde. At the end of 2013, Stork Food & Dairy Systems and Aerox ended – as planned – their activities and consequently also the participation in the PPS Mild Preservation.
Were there any changes in the content of the project?	Not all work packages have been active throughout the whole project execution time. When there was only limited interest from industry, it was decided to stop activities. Moreover, based on the project results and the interest of the partners, a new work package was initiated in 2016 focussing on yeast and moulds in relation to mild preservation.
Are there bottle necks in the execution of the project?	For the development of a new processing technology, different steps have to be taken (e.g. feasibility, research on mechanism and impact, product research, process research, scaling up, implementation. The input from partners is different for the different steps. The work packages were adapted according to the stage of development of the technology. Due to the detailed planning made at the start of each project year, no bottle-necks in the execution of the project were experienced.
Are there changes in the	Cash and in kind contributions of the partners changed during

budget?	the project lifetime, based on results achieved, planning of activities and involvement and focus of the partners. This resulted in both increases and decreases of contributions per partner; this was specified in the detailed planning made at the start of each project year.
Is there a patent application from this PPP?	Yes
Are there spin-offs (contract research, other projects)?	For cold plasma, collaboration was developed in Europe with other organisations active in cold plasma research (Plasma4Food network). Proposals for European research projects were developed for mild preservation technologies of which one (i3-Food) has been granted up till now. New PPS projects have been set up which focus on specific technologies addressed in PPS Mild Preservation. Various contract research projects have started where the insights of PPS Mild preservation are used for applied research.

Results and deliverables	
1. Which deliverables were achieved? (give a short description for each deliverable)	At the start of the project, three main results were foreseen. Below, a description of these results is given and a summary of the main outcomes achieved in the project: • development and demonstration of mild preservation methods combined with industrial relevance, where quality, shelf life and safety of food products are crucial: • PEF for preservation of high quality fruit juices, showing that enhanced shelf life with high quality of the product is possible. • HP and PEF: process conditions for (microbial) safe use of these technologies were determined in the project and applied in industry. • design of sustainable production chains by using these mild preservation methods with special emphasis on reduction of food waste, • Implementation of project results for several combinations of hurdles (ingredient pretreatments, processing conditions, packaging, storage). • The knowledge on impact of mild processing, cooling, storage and product shelf life and quality were integrated in models that are used by partners to evaluate if adaptations in the production chain are possible to enhance shelf life and reduce food waste. • enhanced knowledge and understanding in the effects and safety of mild preservation methods. • Insight in the effect of mild preservation methods on inactivation of spoilage micro-organisms, pathogens and enzymes in different product matrices. • Novel methods for determining e.g. effect of mild preservation methods on yeast and moulds. New monitoring protocols for determining impact of mild preservation**.** • The project resulted in 13 scientific publications up to now; more publications are expected, and a PhD thesis to defended in January 2018. Each year, a detailed planning was prepared for each work package, with the deliverables for each project year. The highlights are summarised in the highlights section of this end report.
2. If specific deliverables were not reached, what was the reason for this?	All main deliverables were achieved in the project. During the project lifetime, each year a detailed planning was made based on the insights achieved and the focus of the project partners, including deliverables which were due in the specific project year.
3. Did the project result in	As always in a scientific research project, part of the results

unexpected outcomes?	could not be predicted at the start of the project. Moreover, new processing conditions were developed for mild preservation technologies based on insights in e.g. microbial inactivation by specific technologies.
4a. When will the partners use the project results?	During the project lifetime, insights and project results have already been implemented by the partners, and it is expected that this will be continued in the coming years.
4b. Is it possible to enhance the use of results by partners, and if yes, how?	For applied research on mild preservation technologies, it is essential that food producers (end users of the technology), equipment manufacturers (technology providers) and researchers (knowledge and insight) are working together. This balance was present in many work packages, but in some work packages one of the actors was missing. When necessary, contact was searched with the missing actors, such as end users or equipment manufacturers. The presence of the Dutch Food Authority (NVWA) was very valuable for the project, as risk assessment and acceptance of new technologies and applications is crucial.
4c. How was the dissemination of project results organised?	A special work package (WP Dissemination) is focussing on the dissemination of the project results outside the consortium. The aim of this work package is to disseminate the knowledge generated in the PPS Mild Preservation. The main categories of dissemination are: • Workshops: workshops were organised for e.g. industry, experts, and associations. These workshops were organised as a stand-alone-activity or in combination with other (inter)national events. • Publications (scientific, professional journals): Both scientific publications in peer reviewed journals and more applied publications in professional magazines were published during the project. • Presentations at conferences: research results were presented at various scientific and professional conferences. • Dissemination to wider public: in addition to the scientific and professional communities, dissemination was done to the general public, including contributions to newspapers, general magazines and Dutch television programmes. • Communication between project partners: in addition to general project meetings, work package meetings and –reporting, an internal newsletter was developed which provided a 6 month update of the project activities. On 17 March 2017, a final workshop was organised for industrial stakeholders to communicate the main outcomes of the project.
5. How did the project contribute to the knowledge development of the research institute involved?	The insights generated in the project contributed to the strong position of Wageningen Food & Biobased Research on mild preservation of food products, resulting in new projects, new collaborations with industry and other knowledge institutes and new applications of mild preservation technologies. Up to now, the project resulted in 13 scientific publications, more publications are expected, and a PhD thesis is expected to be defended in January 2018.
6. Will the project be continued by new projects or new cooperation?	For cold plasma, collaboration was developed in Europe with other organisations active in cold plasma research (Plasma4Food network). Proposals for European research projects were developed for mild preservation technologies of which one (i3-Food) is granted up till now. New PPS projects were set up which focus on specific technologies addressed in PPS Mild Preservation. Various contract research projects were started were the insights of PPS Mild preservation are used for applied research.

Highlights: give a short description of the main results

The project is divided into technology-oriented work packages (pulsed electric fields, e-cooking, cold plasma, high pressure sterilisation, hurdle technology and radio frequency heating) and integrating work packages (chemical safety and impact on nutrients, risk assessment and dissemination and knowledge transfer). For each work package, a short summary is given of the aim of the work package and the key scientific insights achieved.

<u>WP 1 Pulsed electric field processing</u>

The aim of this work package is to enhance knowledge and insight in the use of pulsed electric fields (PEF) and of PEF based processes for preservation of food. Focus is on product safety in combination with the influence of PEF on product quality.
The key scientific insights are:

- Effect of PEF conditions and food matrix on inactivation of spoilage microorganisms and pathogens
- Evaluation of potential of PEF treatment for preservation of milk
- Impact of PEF on inactivation of yeast and moulds
- Potential of PEF for products with longer shelf life and products with neutral pH.
- Effect of PEF on inactivation of enzymes and on product quality

The results in this work package contributed to a better understanding of the impact of PEF processing conditions on microbial safety and shelf life and the influence of the product matrix on this. These results are therefore essential for the product safety and showed also the limitations of the process for products with neutral pH.

<u>WP 2 E-cooking</u>

The aim of this work package is to enhance the knowledge and insights of the conditions necessary for an optimal, safe, and sustainable application of pulsed power processes or e-cooking for heating and preparation of foods.
The key scientific insights are:

- Development of a method to measure temperature distribution during e-cooking
- Insight in homogeneity of temperature during e-cooking
- Insight in inactivation of microorganisms with e-cooking
- Pilot study microbial safety e-cooking.

The results in this work package contributed to the understanding of the effects of e-cooking on food products. With the developed temperature method, the homogeneity of the process was shown.

<u>WP 3 Cold plasma</u>

Cold plasma is a potentially interesting method for disinfection of surfaces of packages and food products. The aim of this work package is to generate insight in the process for the technical and economic feasibility of plasma gas for decontamination of food products and packaging materials.
The key scientific insights are:

- Mechanistic insights in the effects of cold plasma on micro-organisms
- Insight in inactivation of spores with cold plasma
- Development of a method to diagnose gas plasma composition
- Potential of cold plasma for disinfection of PET bottles
- Development of potential routes for scaling up of cold plasma.

The results of this work package contributed to the understanding of the mechanism of cold plasma for inactivation of both vegetative micro-organisms and spores on surfaces. Routes for scaling-up of cold plasma were investigated to make this process potentially applicable in (food) industry.

<u>WP 4 High pressure sterilisation</u>

High pressure is applied in industry as pasteurisation method for various food products. The aim of this activity is to increase the knowledge related to high pressure sterilisation and make this knowledge more accessible and to enhance the further development of high pressure sterilisation towards industrial application and valorisation.
The key scientific insights are:

- Development of a method to measure temperature in a product during processing
- Insight in critical points for integration of high pressure sterilisation in processing lines
- Insight in the effects of high pressure sterilisation on food products.

This work packages focused on the insights necessary to overcome the main challenges for implementation of high pressure for sterilisation of food products. More insight was gained on the impact of the process on food quality and the critical points for integration of the process in a processing line.

<u>WP 5 Hurdle technology</u>

In this work package, the starting point is the product and which mild preservation technologies could be used for optimal quality and shelf life. The aim is to get insight in the effects of combination of preservation hurdles on product safety and shelf life.
Key scientific insights are:

- Insight in microbial spoilage of chilled products with neutral pH
- Insight in the effects of hurdles on inactivation and growth of microorganisms
- Modelling of growth of microorganisms during processing and storage
- Insight in the relation between hurdle technology and packaging conditions.

This work package integrated the insights in the different hurdle technologies for enhancing shelf life and product quality of products of neutral pH. The insights in the spoilage microorganisms and impact of processing, storage, and packaging on the inactivation and growth of the spores was linked to product quality.

WP 6 Radio frequency heating

Due to the homogeneous and fast heating, radio frequency heating can be used for continuous pasteurisation of moist food products, such as ready meals, meat products and prepared vegetables. The products retain their freshly cooked taste and bite, together with an enhanced shelf life. Pasteurisation temperatures can be reached in minutes, resulting in an improved product quality.
In 2013, this technology was evaluated and discussions with industry were held to explore the potential of RF heating. Although RF heating can be very interesting for the food industry, due to the homogenous and fast heating that can be achieved, there was not enough interest from industry to continue the research on this technology in later years of the PPS mild preservation.

WP 7 Impact on nutrients and specific components

The aim of this work package is to get insight in the influence of mild preservation of maintaining bioavailability and bioactivity of specific components and demonstrating chemical safety of the processes.
Key scientific insights are:

- Insight in the effect of mild preservation on bioavailability.

This work package contributed to the insight of the effect of mild preservation methods on food quality. Together with the results of the technology oriented work packages (WP1-6) this resulted in increased insight and knowledge of the impact of mild preservation on food quality characteristics like enzyme activity, texture, colour, flavour and preservation of nutrients.

WP 8 Risk assessment of mild preservation technologies

The aim of this work package is to develop a roadmap for risk assessment of mild preservation technologies.
Key scientific insights are:

- Development of a roadmap for mild preservation technologies

Within this work package, a roadmap was developed for risk assessment of mild preservation technologies.

WP 9 Mild preservation technologies and yeast and moulds

Based on the project results in 2013-2015, it was concluded that knowledge necessary of the relation between yeasts and moulds and preservation technologies is required for application of these technologies in industry. In 2016, a separate work package was included in the PPS mild preservation with the focus on yeast and moulds.
The aim of this activity is to get more insight in the potential of mild preservation technologies to better control and eventually prevent spoilage of food products by moulds.
Key scientific insights are:

- Isolation of mould and yeast spoilage isolates were obtained from ingredients and products processed with mild preservation technologies
- Insight in inactivation kinetics of yeasts and moulds by heat, PEF, plasma and different chemical disinfectants.

The outcome of this work package provided insight in the effect of HPP, PEF, plasma and heat on yeast and moulds to prevent spoilage of especially fruit and vegetable products treated with these new technologies.

Aantal opgeleverde producten (geef in een bijlage de titels en/of omschrijving van de producten of een link naar de producten op openbare websites)			
Wetenschappelijke artikelen	Rapporten	Artikelen in vakbladen	Inleidingen/ workshops
13	~50	13	40

Akkoord: Hans van der Kolk (Topsectorsecretaris)

Bijlage: Titels van de producten of een link naar de producten op een openbare website

https://www.wur.nl/nl/project/Milde-conservering-van-levensmiddelen-AF-12148.htm

https://www.wur.nl/upload_mm/3/2/2/319a25f2-4309-4095-a84d-14855ae7de3e_8412102213_AFSG_PPS_Mild_Preservation_online_LR.pdf

http://library.wur.nl/WebQuery/wurpubs/fulltext/376255

Scientific publications of PPS Mild preservation

No	Publication	Description	Date
1	Scientific journal	Vervoort, L.; Plancken, I. van der; Grauwet, T.; Verlinde, P.; Matser, A.; Hendrickx, M.; Loey, A. van; Thermal versus high pressure processing of carrots: a comparative pilot-scale study on equivalent basis. Innovative Food Science & Emerging Technologies; 2012, 1-13	2012
2	Scientific journal	Physiological and transcriptional response of Bacillus cereus treated with low-temperature nitrogen gas plasma. Mols, Mastwijk, Nierop Groot, Abee. 2013. Journal of Applied Microbiology 115: 689-702.	2013
3	Scientific journal	Pulsed electric field processing of different fruit juices: impact of pH and temperature on inactivation of spoilage and pathogenic micro-organisms. Timmermans, Nierop Groot, Nederhoff, van Boekel, Matser, Mastwijk. International Journal of Food Microbiology, Volume 173, 3, March 2014, Pages 105–111	March 2014
4	Scientific journal	Van Bokhorst-van de Veen, H., Xie, H., Esveld, E, Abee, T., Mastwijk, H. Nierop Groot, M.N. Inactivation of chemical and heat-resistant spores of Bacillus and Geobacillus by nitrogen cold atmospheric plasma and comparison to thermal and chemical based methods. Food Microbiology, 2015, Vol.45(part A), pp.26-33	February 2014
5	Scientific book	A.M. Matser, R. Timmermans: Effect of high pressure processing on fruits and vegetables. Contribution to book High Pressure Processing in Food: Technology, Principles and Applications-, eds. B. Balasubramaniam, H. Lelieveld, 2016	January 2016
6	Scientific journal	Timmermans, R.A.H., Nederhoff, A.L., Nierop Groot, M.N., Van Boekel, M.A.J.S, Mastwijk, H.C. Effect of electrical field strength applied by PEF processing and storage temperature on the outgrowth of yeasts and moulds naturally present in a fresh fruit smoothie. Int. Journal of Food Microbiology, volume 230, pages 21-30	2016
7	Scientific journal	Effect of high pressure sterilisation on sensorial and nutritional quality parameters of canned diced and whole peeled tomatoes. Martijntje Vollebregt, Nguyen Thanh Vu, Ruud Verkerk, Vincenzo Fogliano, Ariette Matser. Submitted	2016
8	Scientific journal	Helmond M, Nierop Groot MN, and Van Bokhorst-van de Veen H; Characterization of four Paenibacillus species isolated from pasteurized, chilled ready-to-eat meals. Int. Journal of Food Microbiology, volume 252, pages 35-41	2017
9	Scientific book	High pressure processing combined with heat for fruit and vegetable preservation. Ariette Matser, Martijntje Vollebregt. In: High pressure processing of fruit and vegetable products. Eds. M. Houska, F.V.M. Silva. Accepted	2016

10	Scientific journal	van Der Sman, R.G.M. Model for electrical conductivity of muscle meat during Ohmic heating. Journal of Food Engineering, September 2017, Vol.208, pp.37-47	2017
11	Scientific journal	Timmermans, R.A.H., Mastwijk, H.C., Nierop Groot M.N. & M.A.J.S. van Boekel. Evaluation of the Gauss-Eyring model to predict thermal inactivation of micro-organisms at short holding times. International Journal of Food Microbiology, 263, 2017, 47-60	2017
12	Scientific journal	Timmermans, R.A.H., Mastwijk, H.C., Berendsen, L.B.J.M., Nederhoff, A.L., Matser, A.M., Van Boekel, M.A.J.S. & M.N. Nierop Groot. Systematic evaluation of the effect of pulsed electric field (PEF) processing parameters electric field strength, pulse duration and temperature on the inactivation of micro-organisms in fruit juices. *Submitted for publication*	2017
13	Scientific journal	Timmermans, R.A.H., Roland, W.S.U., Van Kekem, C., Matser, A.M. & M.A.J.S. Van Boekel. Effect of pasteurization by Moderate Intensity Pulsed Electric Field treatment compared to heat treatment on quality attributes of fresh orange juice. *Submitted for publication*	2017
14	PhD thesis	R.A.H. Timmermans. Moderate and high intensity pulsed electric fields. Effect on microbial inactivation shelf life and quality of fruit juices. Successfully defended on 19 January 2018	2018

Other dissemination activities of PPS Mild preservation

No	Publication	Description	Date
1	Publication	Hoogesteger past pulsed electric field toe om houdbaarheid vers sap te verlengen. Dionne Irving. Voedingsmiddelentechnologie, vol. 45, nr 16/17, p. 11-13. August 2012.	August 2012
2	Publication	Twee weken langer houdbaar. Juice keeps two weeks longer. Astrid Smit. Wageningen World, nr. 3, 2012, p. 16-17.	May 2012
3	Television	Contribution to VPRO scientific television program Labyrint. Iedereen heeft smaak. 26 September 2012.	September 2012
4	Award	Nominatie Food Valley Award October 2012. Hoogesteger verse sappen behandeld met fresh micro pulse.	October 2012
5	Presentation	Electroporation as shelf life extension of food. Rian Timmermans, presentation at 'Electroporation Based Technologies and Treatment' conference in Ljubljana, Slovenia, 19 November 2012	November 2012
6	Publication	Lekker lang houdbaar. Peter de Jaeger. De Gelderlander, 15 December 2012.	December 2012
7	Publication	Lekker lang vers. Hightech bewaartechnieken. EOS Magazine, December 2012, p.26-30.	December 2012
8	Publication	Hoge druk sterilisatie logische aanvulling op hoge druk pasteurisatie. M. van der Glas. NPT procestechnologie, May 2013, 28-29.	May 2013
9	Publication	A.M. Matser, M. van der Glas. Milde conservering. Langer houdbaar en supervers. Voedingsindustrie, November 2013, 13-15	November 2013
10	Workshop	20 June 2013, Leeuwarden: Product perspectives with mild processing organised by Food Circle and HANNN	June 2013
11	Television	Vara Kassa Groen NLD2 28 June 2013 18.35h, Dutch television	June 2013
12	Presentation	Recent advances in non-thermal nitrogen plasma as food processing technology. Nierop Groot, M.N., Van Bokhorst-van de Veen H., Esveld, D.C., Mols, M., Abee T., Mastwijk, H. Oral presentation Microbial Spoilers in Food conference in Quimpere, France. 1-3 July 2013.	July 2013
13	Presentation	Fresh fruit juices. Quality, safety and shelf life extension by pulsed electric field treatment. Rian Timmermans. Presentation at 'Gluren bij de buren', 20 September 2013, Wageningen, The Netherlands	September 2013
14	Presentation	Quality, safety and shelf life extension of fresh fruit juices by pulsed electric field treatment. Hennie Mastwijk. Presentation at DrinkTec 2013, 18 September, Munich, Germany.	September 2013
15	Poster	Influence of mild preservation techniques on quality and bioactivity of functional components in broccoli juice. Timmermans, Govers, van der Sluis, Somhorst, Matser. Poster presentation at I-food conference, 8-10 October 2013, Hannover, Germany.	October 2013
16	Presentation	Recent advances in non-thermal nitrogen plasma as food processing technology. Nierop Groot, M.N., Van Bokhorst-van de Veen H., Esveld, D.C., Mastwijk, H. Oral presentation. Ifood Conference, Hannover, 8-10 October 2013.	October 2013
17	Workshop	Mild preservation booth on the Innovatie estafette, 12 November 2013, Amsterdam.	November 2013
18	Workshop	Workshop mild preservation. 28 January 2014,	January 2014

		Wageningen	
19	Publication	S. Mouissie. Is uw eten al gepascaliseerd? Nederlands Dagblad, Monday 14 January 2013	January 2014
20	Workshop	Training mild preservation for experts NVWA, January/February 2014	January/February 2014
21	Presentation	Pulsed electric field processing of fruit juices: impact of pH and temperature on inactivation of spoilage and pathogenic micro-organisms. Oral presentation at PEF school. Zaragosa, Spain, 23 January 2014	January 2014
22	Poster presentation	General presentation PPS Mild Preservation. TKI AgriFood Top on 4th June 2014.	June 2014
23	Workshop	A contribution on mild processing was given at a workshop of the Institute of Sustainable Process Technology, ISPT, 9 September 2014, Amersfoort.	September 2014
24	Presentation and poster presentation	PEF processing at industrial relevant conditions: possibilities and constraints. Presentation and poster presentation, EFFOST food conference 25-28 November 2014, Uppsala, Sweden	November 2014
25	Award	EFFost young scientist award: Rian Timmermans	November 2014
26	Workshop	A workshop session on mild processing was organised at the Agro Food Technology Congress, 3 December 2014, Wageningen.	December 2014
27	Workshop	Mild preservation for the organic sector. Workshop at BioBeurs Zwolle, 22 January 2015	January 2015
28	Workshop	Possibilities for mild preservation for the organic sector. Workshop at BioFach, Neurenberg, 11 February 2015	February 2015
29	Television	Item on high pressure processing in Dutch children program 'Klokhuis'. 2 February 2015	February 2015
30	Publication	Cellen op de elektrische stoel. Hoe elektroporatie de wereld gaat veranderen. Kijk, issue 3, 2015, p 44-47	March 2015
31	Workshop	Mild preservation. NVVL (Network for Food Experts), Wageningen, 19 March 2015	March 2015
32	Workshop	Theme day Mild Preservation. Helmond, 22 April 2015	April 2015
33	Publication	Milde conservering. Stand van zaken. Voedingsmiddelentechnologie, 29 May 2015, nr. 7., p 30-31	May 2015
34	Workshop	Workshop Dutch Association of Nutritionists, Heerenveen, 31 August 2015	August 2015
35	Presentation	Non thermal plasma in food industry: from lab scale towards industrial application. Hennie Mastwijk, Hermien van Bokhorst-Van de Veen, Erik Esveld Masja Nierop Groot. 6 -10 September 2015, 1st World Congress on Electroporation and Pulsed Electric Fields in Biology, Medicine, and Food & Environmental Technologies Venue: Portorož, Slovenia.	September 2015
36	Exhibition at conference	Exhibition activity by IXL Netherlands of the e-Cooker at the 1st World Congress on Electroporation and Pulsed Electric Fields in Biology, Medicine, and Food & Environmental Technologies (6-10 September 2015, Portoroz, Slovenia).	September 2015
37	Workshop	Clean label workshop. Centre for mild processing, Helmond, 6 October 2015	October 2015
38	Presentation	New processing technologies improving health. A.M. Matser. Presentation at Healthy ageing conference, Amsterdam, 29-30 October 2015	October 2015
39	Presentation	Inactivation of spores on surfaces using nitrogen cold atmospheric plasma gas. M. Nierop Groot, T. Dongmin Kim, A. Warda, T. Abee and H. Mastwijk.	November 2015

		Presentation at International Nonthermal Processing Workshop. 12-13 November 2015, Athens. (www.NPSWorkshop2015.org).	
40	Presentation	Hurdle technology to improve organoleptic aspects of broccoli in pressure-assisted thermal sterilisation (PATS). Vollebregt, H.M. Presentation EFFoST conference November 2015 Athens	November 2015
41	Workshop	Workshop Dutch Association of fruit and vegetable processing, Breda, 11 November 2015	November 2015
42	Presentation	Effect of electrical field strength applied by PEF on the shelf life of fresh fruit smoothie: trade-off between yeasts and moulds. R.A.H. Timmermans, A.L. Nederhoff, M.N. Nierop Groot, M.A.J.S. van Boekel, H.C. Mastwijk. Presentation EFFoST conference, Athens, 10-12 November 2015	November 2015
43	Presentation	FIMM conference: Micro-organismen, zo hou je ze in de hand. 26 January 2016, Wageningen	January 2016
44	Publication	Milde conserveringstechniek PEF wordt volwassen. Koen Vandepopuliere, Food Industry, February 2016, 1, 16-17	February 2016
45	Presentation	Inspiratiedag Food 14 March 2016, Groen op je bord. Voedseltransitie: van theorie naar praktijk. Utrecht. Presentation A.M. Matser	March 2016
46	Presentation	A.M. Matser, M. Vollebregt. High pressure high temperature treatment. Potential applications for preservation of food products, with special focus on tomato products. Fruit & Veg Processing 2016, 4-6 April 2016 Avignon	April 2016
47	Presentation	Conference Vers koelen in beweging. Veranderingen in de keten, nieuwe technieken en toekomst van koelen. 16 June 2016, Wageningen. Presentation A.M. Matser	June 2016
48	Workshop	PPS mild preservation. Public workshop presenting the main project results. 17 March 2017, Wageningen	March 2017
49	Publication	We kunnen PEF nu beter sturen. WUR en sapfabrikant werken samen. Annemarie Barbier-Schenk. Voedingsmiddelentechnologie. 30 Juni 2017, p 14-16.	June 2017
50	Presentation	Inactivation of spores of three Penicillium spp. fruit juice isolates by different physical and chemical treatments. June 30th 2017, Quimper, France. Van Bokhorst-van de Veen (presenter), Feng, Abee, and Nierop Groot	June 2017
51	Presentation	Characterization of four Paenibacillus species isolated from pasteurized, chilled, ready-to-eat meals. June 28th 2017, Quimper, France. Helmond M, Nierop Groot M, and Van Bokhorst-v.d. Veen H (presenter)	June 2017
52	Presentation	Flow cytometry to analyse *Penicillium expansum* spores at single spore level and impact of matrix, heat treatment and incubation temperature on spore outgrowth. Louise Nederhoff, Marcel Tempelaars, Tjakko Abee, Masja Nierop Groot. Microbial spoilaers in Food 2017. 28-30 June 2017. Quimper. Frankrijk	June 2017
53	Publication	Mild conserveren met hogedruk en koud plasma. Doet uw bedrijf mee aan een praktijkproef bij de WUR? Annemarie Barbier- Schenk. Voedingsmiddelentechnologie. September 2017	September 2017
54	Presentation	2nd World Conference on Electroporation. Norfolk, USA. Systematic evaluation of the effect of PEF processing parameters electric field strength, pulse duration and temperature on the	September 2017

		inactivation of micro-organisms. R.A.H. Timmermans (presenter), H.C. Mastwijk, L.B.J.M. Berendsen, A.L. Nederhoff, A.M. Matser, M.A.J.S. Van Boekel, & M.N. Nierop Groot.	

Spin offs

	H2020 project	I3-Food. H2020 project on validation and implementation of mild processing methods	Started 1 April 2015
	Bilateral projects	Various bilateral projects with companies on mild processing	2012-2015
	PPS project	PPS oppervlakteontsmetting: hygienic control of processing environment	Started 1 January 2016
	PPS project	PPS Groente- en fruitconserven: improvement of sterilisation of fruit and vegetables	Started 1 January 2017
		Eventueel nog benoemen dat er een plasma voorstel is ingediend bij HTtFtW?	