

Project number: 6566
Funding source: Teagasc

Date: February 2018
Project dates: 1-Aug-2013– 31-Aug-2017

High Pressure Processing to Control Pathogens in Ready-to-eat-Traditional cooked meat products with reduced-sodium, lower preservatives and no artificial colours or flavours



Key external stakeholders:

Processed meats and prepared consumer foods sector, regulators and policy

Practical implications for stakeholders:

Sodium chloride (NaCl) is widely used in ready to eat meats where it supports microbial preservation and safety of meat products but also improves the flavour and colour. However, excessive salt consumption has been connected with negative health impacts. There is a significant challenge to reduce the level of NaCl while maintaining the positive attributes it confers to meat products and there is an opportunity for High Pressure Processing (HPP) to address this challenge. The objectives of this study were to investigate the use of a salt replacer, an organic acid mixture and high pressure processing to retain microbial stability in a reformulated ready-to-eat (RTE) meat product (frankfurters) with significantly reduced NaCl levels. Microbial inactivation was investigated in reformulated vacuum packed frankfurters (1.06% NaCl, 0.94% artisalt, and 0.24% INBAC (organic acid mix), and marinated pork (marinade 20% w/w, Inbac, 3% w/w) following the use of HPP at 400, 480 or 580 MPa. HPP was shown to be a useful intervention to maintain microbial stability and safety in RTE meat products. At low HPP levels, 400 MPa, there was < 1 log reduction in *Salmonella* and *L. monocitogenes* but 580 MPa gave 4-5 log reduction in both pathogens and extended shelf-life with a multiple-hurdle benefit from the addition of organic acid.

Main results:

- In frankfurters with reduced salt (1.2% salt), and no HPP treatment, TVC had reached 10^6 CFU/g in 5 days at 4°C while the addition of an organic acid mix (INBAC) extended this to 14 days. However, when combined with a HPP treatment (580 MPa for 2 min) synergy was observed between the two hurdles with TVC not reaching 10^6 CFU/g until day 60.
- In frankfurters with reduced salt (1.2% salt), and no HPP treatment, *Enterobacteriaceae* had reached levels of 10^4 CFU/g by day 11, but in products treated with HPP (580 MPa for 2 min), no *Enterobacteriaceae* were detected throughout the 60 day storage period at 4°C.
- In frankfurters with reduced salt (1.2% salt), HPP reduced *Listeria* by ~2-3 logs after treatment at 480 or 580 MPa for 2 min respectively, but the presence of INBAC gave a significant multiple hurdle effect with HPP at 480 and 580 MPa yielding reductions of 4-5 logs in the pathogen.
- In all recipes (control, low salt, low salt and INBAC) *Salmonella* was reduced by ~Log 4-5 CFU following HPP treatment at 580 MPa for 2 min.
- HPP at 480 or 580 MPa for 2 min did not reduce levels of *Clostridium* spores in any frankfurter recipe
- In marinated pork, only 400 MPa for 3 min was tested in this study as pressures above this had been shown to have a negative impact on the meat quality. This level of HPP (400 MPa) gave \leq a 1 log reduction in *Salmonella* and *L. monocitogenes*.

Opportunity / Benefit:

High Pressure Processing was shown to be a useful technology to treat processed meats, giving opportunity to develop new innovative products without traditional preservatives and to maintain microbial safety and extend shelf life. A multiple hurdle effect was noted with the addition of organic acids.

Collaborating Institutions: University College Cork

Teagasc project team: Dr Geraldine Duffy
Dr Gemma McCarthy

External collaborators: Dr Malco Cruz
Prof Joe Kerry
Ms Ciara O Neill

1. Project background

Sodium chloride (NaCl) is widely used in ready to eat meats where it supports microbial preservation and safety of meat products but also improves the flavour and colour. However, excessive salt consumption has been connected with an increase in blood pressure, kidney disease and subsequently heart disease or stroke. There is a significant challenge to reduce the level of NaCl while maintaining the positive attributes it confers to meat products. The objective of this study was to investigate the use of a salt replacer, an organic acid mixture and high pressure processing (HPP) to retain microbial stability in a reformulated ready-to-eat (RTE) meat product (frankfurters) with significantly reduced NaCl levels.

2. Questions addressed by the project:

- Does the application of HPP at 400, 480 or 580 MPa to reformulated vacuum packed frankfurters or marinated pork with significantly lower salt levels improve the microbial safety and stability?
- Does the addition of organic acid to reformulated product improve the anti-microbial effect of HPP treatments?

3. The experimental studies:

- Three recipes of Frankfurter
 - a. Control Frankfurter (2 % NaCl)
 - b. Modified Frankfurter (1.06% NaCl and 0.94% artisalt)
 - c. Modified Frankfurter (1.06% NaCl and 0.94% artisalt and 0.24% INBAC:organic acid mix)were used in a spoilage study or else in challenge study where frankfurters were surface inoculated with *Listeria monocytogenes* cocktail (3 strains), *Salmonella* cocktail (3 strains) or *Cl. sporogenes* spores. The frankfurters were vacuum packed and were not treated (control), or HPP treated in a 35l HPP machine at ABFI, Belfast at 480 MPa or 580 MPa for 2 min and then stored at 4°C or 10°C up to day 60. During storage samples analysed and enumerated for the pathogens (challenge study) or in spoilage study total viable plate counts, psychrophilic plate counts, Enterobacteriaceae, lactic acid bacteria
- Pork loins were placed in a marinade (20% w/w) and Inbac (3% w/w) and inoculated with Log₁₀ 5 CFU/g *Salmonella* (cocktail 3 strains) or *Listeria monocytogenes* (cocktail, 3 strains). The pork was then vacuum packed and were not treated (control), or HPP treated in a 35 l HPP machine at ABFI, Belfast at 400 MPa for 3 min, and then stored at 4°C or 10°C up to day 42. During storage samples analysed and enumerated for the pathogens (challenge study) or in the spoilage study, total viable plate counts, psychrophilic plate counts, Enterobacteriaceae, lactic acid bacteria.

Main results:

- In frankfurters with reduced salt (1.2% salt), and no HPP treatment, TVC had reached 10⁶ CFU/g in 5 days at 4°C while the addition of an organic acid mix (INBAC) extended this to 14 days. However, when combined with a HPP treatment (580 MPa for 2 min) synergy was observed between the two hurdles with TVC not reaching 10⁶ CFU/g until day 60.
- In frankfurters with reduced salt (1.2% salt), and no HPP treatment, *Enterobacteriaceae* had reached levels of 10⁴ CFU/g by day 11, but in products treated with HPP (580 MPa for 2 min), no *Enterobacteriaceae* were detected throughout the 60 day storage period.
- In frankfurters with reduced salt (1.2% salt), HPP reduced *Listeria* by ~2-3 logs after treatment at 480 or 580 MPa for 2 min respectively, but the presence of INBAC gave a significant multiple hurdle effect with HPP at 480 and 580 MPa yielding reductions of 4-5 logs in the pathogen.
- In all recipes (control, low salt, low salt and INBAC) *Salmonella* was reduced by ~Log 4-5 CFU following HPP treatment at 580 MPa for 2 min.
- HPP at 480 or 580 MPa for 2 min did not reduce levels of *Clostridium* spores in any frankfurter recipe

- In marinated pork, only 400 MPa for 3 min was tested in this study as pressure above this has been shown to impact on the meat quality. This level of HPP (400 MPa) gave \leq a 1 log reduction in *Salmonella* and *L. monocitogenes*.

4. Opportunity/Benefit:

High Pressure Processing was shown to be a useful technology to treat processed meats, giving opportunity to develop new innovative products without traditional preservatives and to maintain microbial safety and extend shelf life. A multiple hurdle effect was noted with the addition of organic acids.

5. Dissemination:

Cruz-Romero, M., O' Neill, C., Duffy, G. and Kerry J., (2018). The application of response surface methodology for the development of consumer accepted low-salt cooked ham using high pressure processing and a mix of organic acids. *Innovative Food Science and Emerging Technologies* 45: 401–411

Cruz-Romero, M., O' Neill, C., Duffy, G. and Kerry J., (2018). Extending the shelf life of vacuum-packed salt reduced frankfurters and cooked ham by the application of hurdle technology. *Food Packaging and Shelf Life*

McCarthy, G., O'Neill, C., Cruz-Romero, M., Kerry, J. and Duffy G, (2017). The impact of High Pressure Processing on inactivation of micro-organisms in reformulated processed meats. Workshop on HPP at UCC, June 23rd, 2017

Duffy, G. (2016) Practical Demonstration on High Pressure for processing of Food. Teagasc Gateway event on Novel Processing Technologies. November 23rd 2016, at Teagasc Ashtown

McCarthy, G., O' Neill, C., Cruz Romero, M., Patterson M., Kerry J. and Duffy, G. (2016). Investigating the effect of an organic acid mixture in combination with high pressure processing on spoilage microorganisms and pathogens during chilled vacuum-packaged of salt reduced frankfurters. IUFoST 18th World Congress of Food Science and Technology. 21st – 25th August 2016, Dublin, Ireland

6. Compiled by: Geraldine Duffy