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

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. monocytogenes 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 ≤ a 1 log reduction in Salmonella and L. monocytogenes.

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.

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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 35 l 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 Log_{10} 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 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.
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- 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.
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• 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 ≤ a 1 log reduction in *Salmonella* and *L. monocytogenes*.

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). Extending the shelf life of vacuum-packed salt reduced frankfurters and cooked ham by the application of hurdle technology. *Food Packaging and Shelf Life*


6. Compiled by: Geraldine Duffy