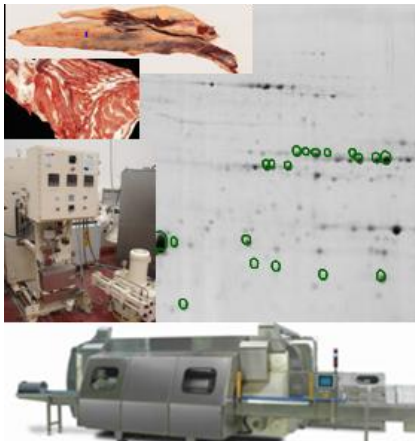
Project number: 5580
Funding source: DAFF (R&D /TAFRC/521)
Date: March, 2012
Project dates: Nov 2006 – Jun 2010

Developing novel convenient meat based products by application of high pressure processing (HP meat).



Key external stakeholders:
Meat processors, chilled ready meal producers, state agencies

Practical implications for stakeholders:
The output of this research provides a broad range of data which can assist many players in the chilled meat product chain to understand the relevance of a minimal processing technology such as high pressure processing (HPP). Results also provide valuable information to assist in understanding at a proteome level how HPP exerts its effects on quality.

- Influence of different HPP treatment levels were observed with lower pressure (200MPa) being more appropriate than higher for meat.
- Higher (600MPa) appeared to be more relevant for processing of vegetables.
- Industry was positively disposed towards the availability of a HPP central treatment facility.

Main results:
- Mild pressure treatments minimally influence meat quality while improving meat hygiene.
- While high pressure levels would promote lipid oxidation, mid-range levels had no impact on fatty acid profile.
- Results suggest increases in pressure result in increased precipitation of sarcoplasmic proteins onto myofibrils.
- Processing at 600MPa and blanching were the treatments that best preserved antioxidant capacity of vegetables.
- The enhanced nutritional profile of the chilled ready meal concept garnered higher levels of consumer acceptance especially amoungst respondents in the family life stage.
- The overall result from the 300 consumers acceptance test indicated that a pressure treatment of 200 MPa was most acceptable to the majority of consumers.
- Further education and technical training is warranted to increase industry awareness of HPP.

Opportunity / Benefit:
This project provides valuable information for scientific and consumer audiences and provides a good starting point for further research or development by others including industry. As a non-thermal treatment which can influence microbial safety, HPP holds potential as a minimal process technology of relevance to the production of ready to eat meat products which are microbiologically safe and possess superior sensory and nutritional attributes. Expressions of interest in further developing this research are welcome.

Collaborating Institutions:
UCC

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1. Project background:

In recent years there has been a growing demand among consumers for ready to eat meat products which are microbiologically safe and possess superior sensory and nutritional attributes. There is an ever increasing emphasis on 'clean-labeling' which alludes to the emergence of new ready meals positioned on a more wholesome, fresh and naturalness platform. In that context, non-thermal food preservation processes represent an alternative to existing process technologies that can potentially meet market requirements for minimally processed foods.

High pressure processing (HPP) is a non-thermal technology used in the food industry because of its capacity to diminish the microbial load while preserving most of the sensory, nutritional and functional properties of the processed food products. HPP can, however, affect functional properties of proteins with the outcome dependent upon protein susceptibility, the applied pressure and temperature, and the duration of the pressure treatment. HPP might also be a suitable technology to process vegetables while preserving its quality. HPP is a mild technology that affects mainly non-covalent bonds, allowing a better preservation of micronutrients such as hydrophilic vitamins, pigments and flavour. While there is growing interest in this technology among players in the meat and ready meal sectors, there are a number of scientific questions which need to be addressed. Additionally it is important to evaluate the current attitude of both the chilled foods industry and the consumers towards this technology.

2. Questions addressed by the project:

- What are the effects of HPP on meat pieces in terms of the altered texture, flavour, nutrient content and colour stability?
- Can we elucidate the mode of action of HPP at the level of the muscle proteome to better understand the impact on quality traits?
- How does HPP influence vegetable components in relation to their texture, nutrient content and colour stability?
- Will consumers accept HPP of a meat based product?
- What are consumers' attitudes to HPP meat products?
- How acceptable is this technology to industry?

3. The experimental studies:

This project was divided into a number of different approaches which for ease of presentation and understanding have been described under the relevant headings below.

Impact of combined effect of high pressure processing (HPP) and temperature on beef and lamb quality was assessed in the brisket. A number of quality traits were evaluated with a particular focus on lipid oxidation and fatty acid composition. Technological aspects of quality were determined by assessing pH, colour and cook loss. Microbiological status was also assessed and shelf-life studies, up to 30 days of storage, were included.

Impact of HPP processing on the proteome in beef brisket. The combined effect of pressure and mild temperature treatments were evaluated on different protein fractions from beef striploin. Proteome platforms of 2-dimensional electrophoreses and mass spectrometry were employed. Quality was also assessed (colour, water holding capacity).

Evaluation of the effect of HPP and thermal processing on quality and nutritional value of selected vegetable components. Turnip and cabbage were treated by high pressure processing at different temperatures. Physical analysis of quality included texture analysis, colour and juiciness while nutritional value included assessment of total phenols, glucosinolates, antioxidant capacity and vitamin C.

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Microbiological status and a shelf-life study were also conducted.

Consumer acceptance of high pressure processed beef-based chilled ready meals and attitudes to the process technology: A consumer interview guide was prepared to assess attitudes towards HPP and a total of 40 respondents were interviewed for this purpose. HPP treated products were prepared and consisted of beef and gravy. These were evaluated by 300 consumers.

Evaluation of Industry attitudes towards HPP technology: In-depth interviews were conducted with five companies involved in chilled ready meal production, to assess attitudes to HPP.

4. Main results:

Impact of high pressure processing (HPP) and temperature on beef and lamb quality: The results show that mild pressure treatments (200 MPa) would minimally affect meat quality parameters, while improving meat hygiene. HPP at higher pressure levels would promote lipid oxidation. However, HPP in the range 200–400 MPa did not alter the fatty acid profile of beef and HPP had less of an effect than cooking over a 30day storage period. In lamb the highest pressure level (600 MPa) had a detrimental effect on quality (texture, water binding properties and oxidation). While all pressure treatments altered meat quality to some extent in some cases this effect was not as pronounced as conventional cooking. Thus, pending further research, HPP may have potential to be used as a pre-treatment of meat in order to reduce the cooking time.

Impact of HPP processing on the proteome in beef brisket: The research team confirmed a relationship between denaturation of the sarcoplasmic protein fraction and alteration of meat quality characteristics. Solubilisation of myofibrillar proteins also occurred as a consequence of HPP. Findings suggest increased precipitation of sarcoplasmic proteins onto myofibrils with increasing pressure levels. The results provide an understanding of the relationship between pressure induced changes at the proteome level and quality changes.

Evaluation of the effect of HPP and thermal processing on quality and nutritional value of selected vegetable components: HPP had a stronger impact than blanching on the physical properties (texture and colour) of vegetables. Processing at 600 MPa and blanching were the treatments that better preserved the antioxidant capacity of turnip and cabbage. These results suggest the potential of high pressure processing at 600 MPa as a possible alternative to blanching for vegetable processing. In general glucosinolates were reduced in most treatments with glucoraphanin being the only unaffected by treatment. For all treatments, microbiological counts were within acceptable limits for seven days.

Consumer acceptance of high pressure processed beef-based chilled ready meals and attitudes to the process technology: Results revealed that the enhanced nutritional profile of the chilled ready meal concept garnered higher levels of consumer acceptance and especially amongst respondents in the family life stage. The research team were also innovative in assessing the end product in a large consumer-based trial. The study showed the potential of HPP to improve the eating quality of chilled ready meals manufactured using a low-value beef cut. The overall result from the 300 consumers acceptance test indicated that a pressure treatment of 200 MPa was most acceptable to the majority of consumers. However, an increase in pressure above 200 MPa did not always elicit lower acceptance scores.

Evaluation of industry attitudes towards HPP technology: Although the industry respondents acknowledged the importance of process innovations they were unaware of emerging novel processes such as HPP. In that context, further education and technical training is warranted to increase their exposure to, and develop their expertise in, emerging process technologies. Extending the shelf-life of chilled ready meals represented the most commercially relevant benefit of HPP from the manufacturer's perspective. They consider the concept of enhanced nutritional profile as a niche market opportunity. Whilst manufacturers were positive towards some of the benefits associated with HPP, the high capital cost represented a significant barrier. Other barriers related to recipe and packaging modifications. Respondents were positively disposed towards a HPP central treatment facility so they could evaluate HPP economically and technologically.

5. Opportunity/Benefit:

This research provides information on a number of levels which will be of benefit to both the research community and to the food industry. The information generated has commercial importance as it will assist

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the industry in optimising minimal processing strategies for meat based ready meals. The commercial value of this data lies in the fact that the scientific and consumer related data has been generated through this project and hence provide a good starting point for further research or development by others including industry.

A gap in further uptake of this research is the provision of a central HPP facility for larger scale industry led feasibility trials. This facility could also be used to provide a service to SMEs for whom the financial commitment of purchasing this equipment is not feasible. Interest is being expressed by the meat industry in this technology. There is some uptake in countries such as Spain (where sliced meats companies use it) but it is not widely used by the industry. Interest has been expressed on a confidential basis by the Irish meat sector but it is not yet implemented in Ireland.

6. Dissemination:

Dissemination has taken the form of peer-reviewed publications, technical publications, conference presentations, workshops and one-to-one discussions with industry.

Main publications:

Marcos, B., Kerry, J.P., Mullen, A.M. 2010. High pressure induced changes on sarcoplasmic protein fraction and quality indicators. *Meat Science*, 85: 115-120.

McArdle, Marcos, B., Kerry, J.P., Mullen, A.M. 2010 Monitoring the effects of high pressure processing and temperature on selected beef quality attributes. *Meat Science,* 86 629–634

Sorenson, D., Henchion, M., Marcos, B., Ward, P., Mullen, A. and Allen, P. (2011).Consumer acceptance of high pressure processed beef-based chilled ready meals: The mediating role of food-related lifestyle factors. *Meat Science*, 87, 81-87.

Popular publications:

Sorenson, D. and Henchion, M. (2010). Consumer insights: bridging the gap between value-added and value creation, *TResearch*, 5, 1, pp12-13.

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