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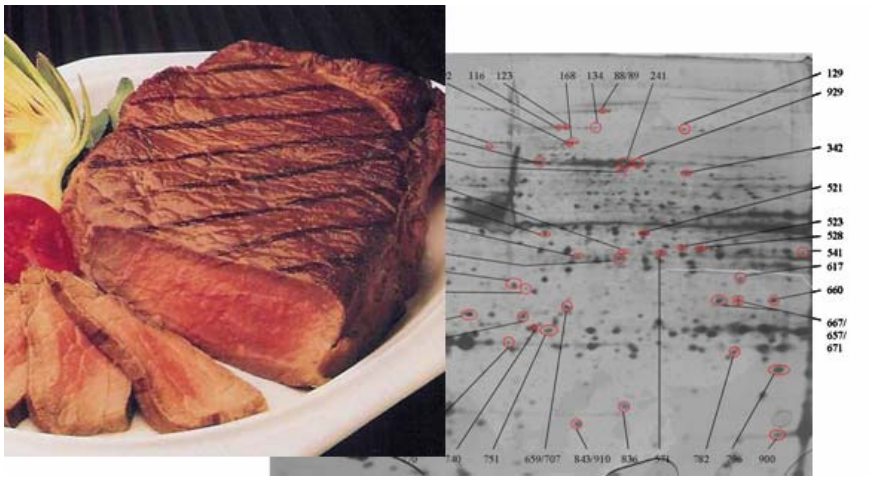
Proteome analysis to improve meat tenderness



Key external stakeholders:

Meat processors, scientific community, government agencies.

Practical implications for stakeholders:

The main outcomes from this research relate to the increased understanding of factors underpinning variability in meat tenderness, with novel proteins identified, and information which will support optimisation of post-mortem carcass management.

- Identification of novel biochemical pathway which is of relevance to the development of tenderness in beef and pork.
- Increased understanding of known biochemical pathways influencing tenderness.
- Optimising post-mortem interventions: importance of factors such as muscle composition, genetic make-up and animal age.

Main results:

- Structural protein degradation, metabolic enzyme systems and cell defense capability in early postmortem muscle contribute to final tenderness differences in beef and pork with a novel protein identified in cell defense pathways.
- Differential protein profiling was observed in response to post-mortem interventions in particular indicating importance of intramuscular fat levels and genetic makeup of the animal when using electrical stimulation.
- Tenderstretch influenced collagen solubility in both muscles while the total collagen content was not changed. Microstructure analysis suggests that a greater separation of the myofibres was observed following tenderstretch treatment.

Opportunity / Benefit:

Knowledge gained from this project could be beneficial in enhancing current grading systems to incorporate a tiered pricing system in terms of tenderness, and defining optimal postmortem intervention practices to provide assurance of tenderness to meet market demand.

Collaborating Institutions:

UCD

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1. Project background:

The meat industry must strive to efficiently deliver a highly palatable product, which ensures a pleasurable eating experience for the consumer and results in a profitable return to both the producer and the processor. In terms of sensory acceptability, tenderness is usually considered the biggest driver. Consumers can distinguish between different levels of tenderness, and they are willing to pay a higher price for tender beef. This shows that there is considerable potential for value addition to high quality meat products. However, inconsistencies in tenderness results in consumers being dissatisfied with beef and pork available at the retail and food service level.

While many advances have been made in optimizing meat tenderness an unacceptable level of variation still remains. While some information is available on biochemical events which occur in muscle and lead to tender meat. Exploring the proteomic signature (a cluster of functional proteins) in early postmortem muscle that determines ultimate meat tenderness can lead to greater insight to the pathways and processes underpinning meat quality. However, there is a need to investigate more thoroughly the methods by which carcass interventions impact on meat quality. In this way, these strategies can be applied in an optimal manner.

2. Questions addressed by the project:

- Can we gain a clearer understanding of changes at the level of the proteome in relation to meat tenderness with a view to increasing our knowledge of pathways and processes underpinning variability in this trait?
- How do post-mortem interventions and the proteome interact to influence meat tenderness?
- Do post-mortem interventions impact on the collagen component of meat?

3. The experimental studies:

Application of tools of proteomics to identify associations with meat tenderness in beef and pork: proteome analysis in tough versus tender meat. Meat samples for proteomic analysis were selected based on scientific criteria regarding tenderness level and an appropriate time point post-mortem.

Analysis of the interaction between early post-mortem carcass interventions, protein profiles and ultimate beef quality with a view to optimisation of these interventions: carcass hanging methods, electrical stimulation.

Investigation of the biochemical and structural properties of post-mortem bovine muscle in animals of different ages.

4. Main results:

Transformations in protein profiles were observed in meat which was tough compared to meat which was tender. Further more detailed inspection of these proteins revealed their identity and pointed the research team towards new biochemical pathways which contribute to the variation in tenderness. Of particular novelty was the profiling of the pork substrate as researchers selected the fluid which exudes from meat.

The research team observed that, in general, structural protein degradation, metabolic enzyme systems and cell defense capability in early postmortem muscle contribute to final tenderness differences in beef and pork. Of particular note is the alteration in cell defense capacity which identified a novel marker and also confirmed the importance of some recently identified pathways. While alterations in structural proteins were known to influence this trait more in depth knowledge was gained on how proteins are affected.

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Differential protein profiling was observed in response to post-mortem interventions, including electrical stimulation and different hanging methods (Achilles tendon and Aitch bone). Post-mortem interventions were successfully applied to influence tenderness and enable comparison of proteomic profiles. Results have inducted that proteolysis, metabolic and stress response are important processes contributing to these effects. The experimental design also enabled observation of the importance of intramuscular fat levels when optimizing electrical stimulation of carcasses. The genetic makeup of the animal may have an influence on this.

Scientists observed a significant improvement of tenderness in carcasses from cows slaughtered at 36 months of age following aitch bone hanging. Both initial toughness (2d and 7d postmortem) values were improved and the level of variation was reduced in the two muscles under investigation. It was also found that the intervention increased the collagen solubility in both muscles while the total collagen content was not changed. Microstructure analysis suggests that a greater separation of the myofibres was observed following tenderstretch treatment.

5. Opportunity/Benefit:

This research has led to a more in-depth understanding of the pathways and processes underpinning variability in meat eating quality by further clarifying known (proteolysis) mechanisms and identifying novel (cell defence) proteins of interest. Data generated also provide guidance for the optimisation of post-mortem carcass intervention strategies.

The results of these studies which were developed with a view to improving the delivery of consistency in meat tenderness clearly indicate the influence of commercially used carcass interventions on the process of tenderisation in beef and pork muscle and the associated proteomic response. Results also highlight the influence of breed and age diversity in this regard. This indicates the multifactorial nature of the development of tenderness and will inform optimisation strategies for meat management systems. In this regard the information is of benefit to the Irish meat industry (both processors and producers) and to the consumer.

In addition this research of benefit to the scientific community as it proves the advantage of using state-of-art proteomic platforms to better describe the biochemical pathways and processes underpinning traits of economic relevance.

6. Dissemination:

The outputs from this research have been, and continue to be, disseminated to stakeholders (meat processors, scientific community, government agencies) in a number of ways a sample of the main and popular publications are shown:

Main publications:

- Mullen, A.M., Corcoran, D., Hughes, L., Hamill, R.M., Cairns M. and Sweeney T. (2007). Developments in genome technologies for improvements in quality of meat. *Meat Technology*, 48: 16-28.
- Mullen, A.M., Stapleton, P.C., Corcoran, D., Hamill R.M. and White A. (2006). Understanding meat quality through the application of genomic and proteomic approaches. *Meat Science* 74 (1): 3-16
- Di Luca, A, Mullen, AM, Elia, G, Davey, G and Hamill, RM (2011). Centrifugal drip is an accessible source for protein indicators of pork ageing and water-holding capacity. *Meat Science*, 88 (2): 261-270

Popular publications:

- Mullen AM., Corcoran D., Hughes L., Hamill RM. 2007. Genomic and Proteomic Approaches to Understanding and Enhancing Meat Quality. *Feedinfo* News Service Scientific Reviews. March 2007. Available from URL:http://www.feedinfo.com.
- Mullen, A.M. (2008) AFRC focus on genomics. In, *The Ashtown Food Innovator*, Issue 2 Summer, 2008, pp. 1.
- Downey, E. (2008). The search for protein biomarkers to improve beef tenderness. In, *The Ashtown Food Innovator*, Issue 2, Summer 2008, pp. 3.

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