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Nutritional composition, human health implications and marketing opportunities for beef from a grass-based production system

Key external stakeholders:
Beef farmers, beef processors, Bord Bia, health professionals, Food Safety Authority of Ireland (FSAI), Teagasc advisory service, agri-consultants, scientific community.

Practical implications for stakeholders:
Differences in the nutritional composition of beef from a lifetime grass/grass products production system compared to beef from a system based on concentrate feeding were confirmed and quantified.

- The findings support the perception of grass-fed beef as having an enhanced nutritional composition from a human health perspective.
- The findings will also assist the marketing of Irish grass-produced beef.

Main results:

- Compared to concentrate-fed beef, grass-fed beef had:
  - higher concentration of Na, Mg, P, K, Ca, Mn, Fe, Cu, Zn, Se, Vitamin E, cholesterol and omega-3 fatty acids
  - lower concentration of total and saturated fatty acids
- A modelling exercise demonstrated that consumption of grass-fed beef has the potential to change the composition of dietary fatty acids and to improve population adherence to dietary recommendations

Opportunity / Benefit:

Data on the nutritional composition could further underpin the unique selling point (USP) of Irish grass-fed beef.
The data suggest that habitual consumption of grass-fed beef is a potential public health strategy to improve dietary fat quality.

Collaborating Institutions:

University College Dublin

Contact Aidan Moloney Email: aidan.moloney@teagasc.ie

Teagasc project team: Dr. Aidan Moloney (PI)
Dr. Edward O'Riordan
Dr. Maeve Henchion
Dr. Cormac McElhinney (Post-Doctoral Fellow)
Paul Moreton (Research Technician)
Bradley Afanda (Research Technician)

External collaborators: Prof. Frank Monahan UCD
Dr. Nigel Brunton UCD
Prof. Helen Roche UCD
Dr. Beige McNulty UCD
Prof. Fiona McGillicuddy UCD

1. Project background:

According to Bord Bia, over 90% of Irish beef is exported. Ireland's competitive advantage of abundant grass growth, whereby animals can graze *in situ* for up to 8 months of the year has facilitated the development of "grass-fed" as a point of difference for Irish beef in high-value EU markets. Emerging markets for Irish beef such as the United States and elsewhere, can define "grass-fed" such that the animal can only consume grass or grass products throughout its life. Compared to concentrate-fed beef, grass-finished beef can have a higher concentration of many nutrients, such as n-3 polyunsaturated fatty acids (PUFA) and conjugated linoleic acid (CLA), considered to be of benefit to human health particularly in relation to the prevalence of obesity, and its progression to associated co-morbidities including insulin resistance, type 2 diabetes and cardiovascular disease. It can be hypothesized that lifetime consumption of grass or conserved grass by cattle would increase the concentrations of these nutrients beyond those reported for beef from grass-finished cattle i.e cattle that received some concentrates prior to grazing. In addition, confirmation of the putative health benefits would assist in maintaining and/or expanding the premium position of "grass-fed" within beef markets and enhance the health of the beef consumer by encouraging selection of grass-fed beef. In Ireland, cattle may also be housed and fed a conserved grass ration supplemented with a non-forage-based energy source up to 50% of the diet, especially during the animal finishing phase, with a consequent decrease in the concentration of beneficial nutrients. This may be addressed by enrichment through strategic supplementation. There is therefore an urgent need for information on the relative nutritional composition and health benefits of grass-fed, concentrate-fed and enriched grass silage plus concentrate-fed beef. Capturing the nutritional/health value associated with altering production systems to enhance the nutritional profile of beef will require the development of marketing strategies which have a strong emphasis on communicating such benefits in an understandable, credible and verifiable manner. This project also addresses this issue.

2. Questions addressed by the project:

- What is the relative nutritional composition of grass-fed, grass silage and concentrate–fed and concentrate-fed beef?
- What the implications of differences in nutritional composition for the health of the beef consumer?

3. The experimental studies:

Spring-born progeny of early maturing Aberdeen Angus sires used on early maturing dams (n=60) were assigned to one of four production systems namely: 1) Barley-based concentrates *ad libitum* 2), Grass/grass products only, 3) Grass silage plus 0.45 dietary intake as concentrate, 4) Grass silage plus 0.45 dietary intake as concentrate but with the concentrate supplemented to enhance the fatty acid profile of tissue of animals consuming this ration. At the end of the winter phase, animals in treatment 1 remained indoors and continued to be fed as for the winter while animals in treatments 2, 3 and 4 were turnout out to pasture. The timing of slaughter was based on the live weight estimated to yield a mean carcass weight of 260 kg. Approximately 3 months before the target live weight, animals in treatments 3 and 4 were rehoused and offered the grass silage-based ration described above. At 48 hours post mortem, the *longissimus, psoas major, semi-tendinosus and supraspinatus* muscles were collected, cooked according to a standard sous-vide protocol and the nutritional composition analysed in Grange. Fatty acid data were subsequently used in a modeling exercise using the National Adult Nutrition Survey database (UCD). Additional tissue was collected for use in studies using rodent models of human disease and in an acute human intervention study in UCD.

Contact Aidan Moloney Email: aidan.moloney@teagasc.ie

4. Main results:

Animal production

The target average slaughter weight was achieved and heifers in all treatment groups achieved the required market specification for carcass fat score.

Nutritional composition

- Compared to concentrate-fed beef, grass-fed beef had a higher concentration of Na, Mg, P, K, Ca, Mn, Fe, Cu, Zn, Se,Vitamin E and cholesterol.
- For Se and vitamin E concentrations, grass silage/concentrate-fed beef was intermediate
- Ration type didn't change the number of nutrients that can be labelled "source of" in concentrate-fed beef.
- Compared to concentrate-fed beef, grass-fed beef had lower concentration of total and saturated fatty acids and higher concentration of omega-3 fatty acids: but the increase was not sufficient for grass-fed beef to be labelled a "source"!
- Grass silage/concentrate-fed beef had a "healthier" fatty acid profile than concentrate-fed beef. This could perhaps be an opportunity to label as "Grass-based".

Fatty acids in the diet of the beef consumer

The modelling exercise indicated that consumption of grass-fed beef rather than concentrate-fed beef has the potential to change the composition of dietary fatty acids and to improve population adherence to dietary recommendations

Human health

In a mouse model, replacing concentrate-fed beef with grass-fed beef did not modulate glucose tolerance, adipose tissue inflammation or atherosclerosis. In an acute human intervention study, there was no significant difference in the change in plasma fatty acids, triglycerides (TAG) or glucose metabolism from before or 4 hours after volunteers consumed a meal based on grass-fed beef or concentrate-fed beef. A medium/long term intervention study is required to define impact of habitual grass-fed beef consumption on metabolic health.

5. Opportunity/Benefit:

Data on the nutritional composition could further underpin the unique selling point (USP) of Irish grass-fed beef. The data suggest that habitual consumption of grass-fed beef is a potential public health strategy to improve dietary fat quality.

6. Dissemination:

Diverse visiting groups to Grange/Ashtown; Beef Advisory Newsletters; GrassBeef project workshop (Ashtown, December 2018); Beef Open days (Grange, 2016, 2018); Workshop: Sustainable beef quality for Europe. Milan, Italy (February 2017); Newspaper interview (January 2019). Presentation at Burren Winterage festival.

Main publications:

McElhinney, C., O'Riordan, E., Monahan, F.J. and Moloney, A.P., (2017). 'The fatty acid composition of cooked *longissimus* muscle from grass-fed, concentrate-fed or grass silage and concentrate-fed heifers' *63rd International Congress of Meat Science and Technology,* 303-304.

Moloney, A.P., McElhinney C., O' Riordan E.G., Monahan F.J. and Richardson R.I. (2018). 'Colour and sensory characteristics of *longissimus* muscle from grass-fed or concentrate-fed heifers' *Grassland Science in Europe*, 23 758-760,

Lenighan, Y., Nugent, A., Moloney, A. P., Monahan, F., Walton, J., Flynn, A., Roche, H.M. and McNulty, B. (2019.). A modelling approach to investigate the impact of consumption of three different beef compositions on human dietary fat intakes. *Public Health Nutrition,* 1-11.

Popular publications:

Moloney, A.P., O'Kiely, P., O'Riordan, E.G and McGee, M (2016) 'Does nutritional management affect beef quality' *TResearch* 11 (2), 18-19

Moloney, A., McGee, M., O'Riordan, E., O'Sullivan, E. and Kerry, J. (2018) 'On-farm influences on the eating quality of beef'. In: *BEEF 2018*, '€nhancing Knowledge', Tuesday, 26th June 2018, Teagasc, Grange, Dunsany, Co. Meath, p164-167. Eds. M. McGee and A. Moloney, ISBN: 978-1-84170-646-7.

7. Compiled by: Dr Aidan Moloney

Contact Aidan Moloney Email: aidan.moloney@teagasc.ie