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Can the producer influence beef quality for the consumer?

Aidan Moloney[1], Padraig O'Kiely[1], Mark McGee[1], Edward O'Riordan[1], Lara Moran[2] and Paul Allen[2]

[1]*Teagasc, Grange Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath.*
[2]*Teagasc, Food Research Centre, Ashtown, Dublin*

Summary

- Increasingly farmers must produce beef to specific market specifications.
- The diet of cattle can affect the colour of fat but has little effect on the colour of lean meat. Among breeds, Jersey-sired cattle have more yellow carcass fat than other breeds.
- Post-farm management has as greater effect on tenderness than on-farm management.
- When slaughtered at a similar fatness, there is little difference between breeds in tenderness or overall consumer acceptability of meat.
- The diet of cattle can influence the amount of healthy compounds in beef.
- Based on current evidence, increasing age at slaughter (up to 22 month at least) does not negatively influence the tenderness of suckler or dairy bull beef but the type of production system may have a small effect.
- Considerable opportunity exists among on-farm production options to meet market specification.

Introduction

Purchasers of beef at all points in the production chain (e.g. factory or retail buyers, processors, restauranteurs, individual shoppers, etc.) can each be considered as beef consumers. As more than 85% of Irish beef is exported there are a myriad of markets and consumers for Irish beef. Each consumer may therefore have a different definition of beef quality. The challenge for beef farmers is to know the preferences/requirements of their target consumer and to most cost-effectively meet these requirements. Within the broad definition of beef quality, the appearance, shelf-life and eating quality can be affected by management of the animal on-farm, during transport and slaughter, management of its carcass during the early post-slaughterer period and management of its meat during maturation and cooking. An objective of the Teagasc meat quality research programme is to provide beef farmers with the information to allow them to produce beef that is suitable for specific markets. It is important to note that the effects of the diet of cattle on beef quality may be direct i.e. other carcass traits have not changed, or they may be indirect i.e. factors such as carcass weight, age or fatness may change as a result of a change in diet and these may then influence beef quality.

Colour of beef

Fat

Consumers in some EU markets, particularly in Mediterranean countries, require carcasses that have white fat. The diet of beef cattle can change fat colour. The yellowing effect on fat of different feeds can be ranked in decreasing order as follows: grazed grass, grass silage/concentrates, concentrates/straw, maize silage and finally whole-crop wheat silage, as shown in figure 1. The colour of fat from cattle fed a barley grain-based ration was similar to that of cattle fed maize grain or fodder beet-based rations. Carcass fat from Jersey-sired cattle was more yellow than that from other breeds.

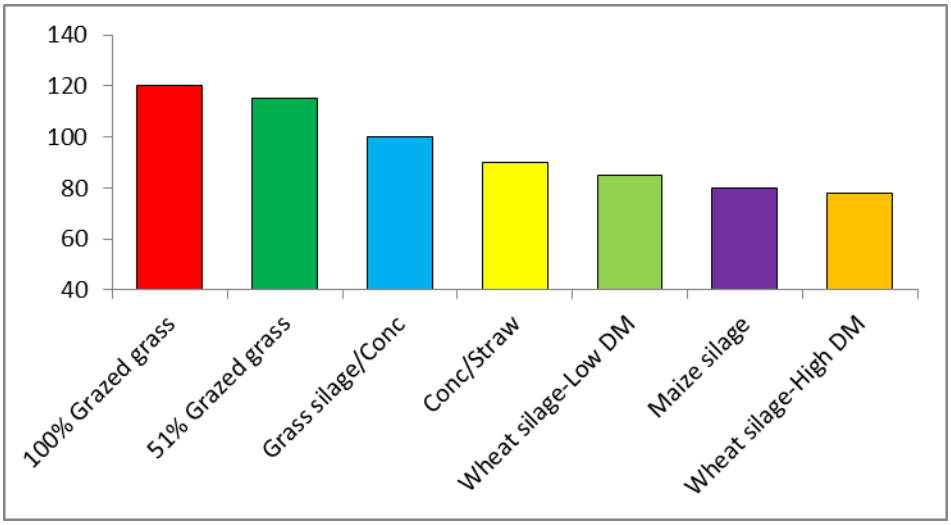

Figure 1. The yellowing effect of different feeds on carcass fat (grass silage + concentrates = 100; higher values are more yellow.

Meat

The appearance and/or colour strongly influence the decision to purchase an individual cut of meat. Consumers generally choose bright red rather than darker meat. In our studies we see little effect of concentrate-based rations, concentrate type or grazed grass *per se* on lean meat colour. There are however, reports of darker meat being produced from grazed cattle compared to 'feedlot' cattle in the United States but these studies are usually confounded by differences in animal age at slaughter and the management of the grazing animals is more extensive than that practised in Ireland. Animal age appears to be a more important determinant of meat colour than diet with younger cattle having meat that is lighter and less red in colour. Minimising pre-slaughter stress is important, particularly for bulls, to ensure that meat does not become dark due to the higher than normal pH that develops in the muscle of stressed animals. The shelf-life or colour stability of beef can be affected by the diet consumed by cattle. The shelf-life or colour stability of beef can be affected by the diet consumed by cattle. In general, grass-fed beef has a longer shelf-life than concentrate-fed beef, mainly due to the greater amount of anti-oxidants present in the meat. Increasing the susceptibility of the fat in beef to oxidation can decrease its colour stability and therefore, a high-fat diet offered to cattle may need to be supplemented with an anti-oxidant such as vitamin E.

Nutritional quality of beef

Beef is generally recognised as a good source of protein, minerals and anti-oxidants but there is also a perception that beef is rich in "unhealthy" saturated fatty acids. However, lean beef with less than 4% fat can be considered a low-fat food. The emphasis on decreasing the consumption of saturated fatty acids is being increasingly questioned, but medical authorities currently advise a decrease in their consumption and an increase in the consumption of monounsaturated and polyunsaturated fatty acids (PUFA). Within the PUFA, increasing the intake of omega-3 fatty acids is particularly encouraged. Conjugated linoleic acid (CLA) is a fatty acid in beef that may protect against cancer and other diseases. Cattle nutrition is the major factor influencing meat fatty acid composition. An increase in energy consumption by cattle can increase the fat concentration in beef (intramuscular fat or marbling), and this in turn can influence the fatty acid composition independent of the nature of the diet offered. Feeding grass and/or feeding concentrates containing linseed, fish oil or algae, compared to a standard concentrate ration, results in beneficial changes in the omega-3 PUFA and CLA in beef. These benefits can be enhanced further by preventing dietary PUFA from being digested (hydrogenation) in the rumen by feeding 'protected' forms of supplement. When rumen-protected PUFA were fed to cattle, the concentration of beneficial omega-3 PUFA increased to an extent that the meat complied with the European Food Safety Authority definition of a "source" of omega-3 PUFA. However, this beef had a shorter shelf-life, indicating that additional dietary anti-oxidants were required in the supplement fed to the cattle. There is considerable interest in the possible health benefits of grass-fed beef. While the levels of omega-3 PUFA in grass-fed beef are below the definition of a 'source', grass-fed beef can contribute to overall omega-3 PUFA consumption. Research on the potential human health benefits of grass-fed beef is underway in a

collaborative project between Teagasc and University College Dublin – supported through the Department of Agriculture, Food and the Marine Competitive Research Programmes (13/F/514). The challenge for the food industry is to develop strategies to market grass-fed beef as a meat that is more in line with human health requirements than alternative sources.

Eating quality of beef

Tenderness is considered to have a major influence on the enjoyment that comes from eating beef. Overall acceptability is an assessment of satisfaction which also incorporates flavour and juiciness. Post-slaughter management of the carcass, such as rate of cooling, electrical stimulation and, in particular, ageing/hanging can have a big influence on tenderness and overall acceptability. Equally, how the beef is cooked can influence its overall acceptability. Thus, the treatment of the meat from carcass to plate can mask the effects of the diet of the animal on the farm.

In general, if slaughtered at the same carcass weight/fatness, the composition of the diet does not greatly influence beef tenderness or overall acceptability. For example, in a recent study at Teagasc, Grange, early-maturing breed heifers were fed concentrates *ad libitum* or un-supplemented grass silage followed by grazed grass from weaning until slaughter at a similar carcass weight (260 kg) and there was no difference in tenderness and overall acceptability of the meat.

An increase in energy consumption by cattle will increase growth and carcass fatness. If slaughtered at the same age, carcasses from cattle fed the higher energy ration will likely be fatter and since fat has a small positive influence on tenderness, an apparent positive effect may be seen. Generally, growth rate before slaughter does not greatly influence beef tenderness; however, there is some evidence that rapid growth following a period of restricted growth decreases tenderness compared to meat from cattle that grow at a more even rate throughout the finishing period.

When slaughtered at a constant carcass fatness there is little difference between breeds in tenderness. For example, striploin from Belgian Blue x dairy heifers, slaughtered at a carcass weight of 327 kg, had similar intramuscular fatness and overall acceptability to striploin from Angus x dairy heifers slaughtered at a carcass weight of 237 kg (Table 1). In this study there was an improvement in overall acceptability of the striploin as the animals became older.

Table 1. Carcass and meat characteristics of Angus x dairy and Belgian Blue x dairy heifers slaughtered at two live weights.

	Angus-cross		Belgian Blue-cross		Significance	
	Light	**Heavy**	**Light**	**Heavy**	**Breed**	**Age**
Carcass (kg)	237	305	256	327	**	**
Fat score (1-5)	3.44	4.20	2.49	3.73	*	**
Intramuscular fat (g/kg)[1]	49	67	38	41	*	*
Tenderness[2]	4.31	4.65	4.48	4.76	NS	*
Juiciness[2]	5.06	5.48	5.24	5.27	NS	*
Beef flavour[2]	4.46	4.58	4.26	4.46	*	*
Abnormal[2]	1.93	1.94	2.06	2.29	**	**
Overall acceptability[3]	46.6	52.7	41.5	46.6	*	*

[1] Note: significant interaction between breed and age.
[2] Categorical scale: 1 (least) – 4 (most); [3] Line scale: 0 (least) – 100 (most)

The age at which an animal, particularly a bull, is slaughtered is of current interest specifically with regard to beef tenderness and overall acceptability. Recent Teagasc studies indicate that there is little commercially important difference in tenderness or overall liking of striploins from late-maturing continental breed sired suckler bulls slaughtered between 15 and 24 months of age or from dairy bulls slaughtered at 16, 19 or 21 months of age. There was some evidence that production system *per se* may have a small negative effect on eating quality. For example, when suckler bulls from early- or late-maturing breed sires were slaughtered at 380 kg carcass from an *ad libitum* concentrate diet or grazed prior to finishing on an *ad libitum* concentrate diet, the tenderness rating by trained assessors was lower for the grass-based system. The scale of this decrease is unlikely to be detected by

untrained consumers. There was little difference between early- and late-maturing breed types. This topic is still under investigation, as is comparison of bulls and steers from the beef suckler herd and the dairy herd within a project supported through the Department of Agriculture, Food and the Marine Competitive Research Programmes (11/SF/322).

Conclusions

The expectations of the customer/consumer at each point in the supply chain must be satisfied. This requires clear market signals on the requirements and/or preferences of each consumer group in the production chain. To sustain the beef industry, beef farmers must also be adequately rewarded for meeting marketing specifications, especially if it is more expensive, or more challenging, to produce novel or "enhanced" beef. Information is now available to assist farmers to more consistently meet consumer requirements.

Acknowledgements

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Footnote comment from Simon Marsh, Principal Lecturer – Beef Cattle Specialist, Harper Adams University.

In April 2014 some 36 Charolais cross Limousin/Friesian heifers weighing approximately 509kg at 24.4 months old were reared through to slaughter at Harper Adams and fed *ad libitum* cereal (barley) based rations with free access to straw. The study evaluated the effect of the inclusion or either 1.5% or 3% marine algae on cattle performance. The rations were formulated to contain 141g crude protein/kg DM (12% CP as fed), 12.9 ME (MJ/kg DM) and 345g/kg starch. Overall performance was very good with the heifers recording a mean daily live weight gain (DLWG) of 1.58kg over the 95 day duration of the study resulting in a mean slaughter weight of 660kg. The mean carcase weight was 350.2kg equating to a kill out of 53.1% with carcasses grading R4L/4H. There were no significant differences in animal performance or carcase characteristics with the inclusion of marine algae in a cereal based ration fed *ad libitum* to Continental bred beef heifers. The inclusion of 1.5% marine algae resulted in a small increase in feed intakes; however the inclusion of 3% marine algae resulted in the lowest feed intakes which are in agreement with Vatensever *et al.,* (2000). With similar DLWGs across the three treatments the estimated feed conversion ratios (FCR) reflected the respective feed intakes with the 3% marine algae recording the best FCR.

Striploins were analysed and in agreement with previous work showed that the inclusion of marine algae resulted in beneficial changes in the omega-3 PUFA and CLA in beef. However when the beef flavour was assessed by a trained panel they detected a 'marine odour' in the algae fed cattle!