

Improvement of meat quality in commercial beef and pork production systems

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Abstract

Meat quality is becoming more important as consumers worldwide are increasingly demanding consistently higher quality meat. This article looks at the improvement of meat quality and also focuses on applied animal husbandry practices that can influence meat quality. Breeding technology for meat quality is still in its infancy, and will only accelerate with new developments in genetic markers, gene discovery and the *in vitro* measurement of meat quality. Slaughter and post-slaughter processing is known to influence meat quality. However the less known management practices that also influence meat quality is also described, with an indication of the role of the seed stock industry.

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Introduction

The term meat quality refers to a wide range of attributes such as shopping experience, that is the visible quality of fresh meat (colour, drip, marbling), eating quality of prepared meat (tenderness, juiciness, flavour) processing quality of meat, healthiness and the natural image as perceived by consumers (Monin *et al.*, 1998; Sellier, 2006). The question that arises is what emphasis should be put on the different traits according to market requirements, e.g. which meat quality traits should be included in the breeding goal.

Furthermore, meat quality is not easily measured or predicted on the live animal, and the additive variation of meat quality traits is low to medium, with heritability estimates of between 0.10 and 0.30 (Sellier, 1998; Marshall, 1999; Burrow *et al.*, 2001; Johnston *et al.*, 2003). The only exceptions are subcutaneous fat, intramuscular fat and marbling score with heritabilities of up to 0.50 (Marshall, 1994; Sellier, 1998; Marshall, 1999; Burrow *et al.*, 2001).

With the exception of a few branded products, such as Angus beef in the USA, and the Meat Standards Australia (MSA) beef grading scheme, meat quality is generally not considered in commercial carcass classification systems and the commercial producer or feedlot operator is consequently not rewarded for it. There is thus a lack of real incentives for producers to improve meat quality through breeding. As a result of this, it is not straight forward to derive an economic weight in aggregate breeding values.

Breeding and meat quality

According to Sellier (2006) the first question to be addressed is to what extent does breeding for performance traits affects meat quality. The general trend seems to be a weak to moderate trait- and population-dependent genetic antagonism between performance traits and meat quality (Cameron *et al.*, 1999; Suzuki *et al.*, 2005). In the case of pigs the situation is different when efficiency is considered, with much higher unfavourable genetic correlations (0.30 – 0.40) between meat quality traits and feed efficiency (de Vries *et al.*, 1994; Hermehc *et al.*, 2000; Tribuot & Bidanel, 2000; Lonergan *et al.*, 2001). Divergent selection for residual feed intake (RFI) in pigs resulted in meat with a lower pH and paler colour in the efficient line (lower RFI).

In the case of cattle, moderate to strong genetic and phenotypic antagonisms exist between carcass fat traits and retail beef yield (Koots *et al.*, 1994; Marshall, 1999; Burrow *et al.*, 2001). Tenderness also has an antagonistic correlation with carcass weight and retail beef yield (Koots *et al.*, 1994).

Genotypes

Although many scientists and producers have suggested that controlling the genotype of the slaughter population will solve the beef industries tenderness problems, Koohmaraie *et al.* (2005) concluded that the environmental factors make a much larger contribution to variation in tenderness. It may therefore be easier and cheaper to improve meat tenderness through management and processing procedures, than through breeding.

It is true that some breeds of cattle produce more tender meat than others (Wheeler *et al.*, 2001), and it is well documented that the toughness (shear force) of meat increases as the percentage of *Bos indicus* genes increases. Meat from cattle with 50% or more *Bos indicus* (Brahman, Nelore, Sahiwal) blood tends to be less tender (Koohmaraie *et al.*, 2005). In contrast to this the Sanga cattle (Afrikaner, Bonsmara, Nguni, Tuli) from southern Africa tend to have very tender meat (Strydom *et al.*, 2000; Wheeler *et al.*, 2001). Several other breeds (Jersey, Pinzgauer, South Devon, Angus, Red Poll, Piedmontese) also tend to produce meat that is more tender than meat from other breeds (Koohmaraie *et al.*, 2005).

It is important to realize that there is more variation within breeds for meat tenderness than between breeds, and this variation can be exploited (Koohmaraie *et al.*, 2005). This will require identifying those sires whose progeny produce more tender meat, either through progeny testing or some form of direct measure to predict tenderness.

Genetic Markers

Meat producers have been promised for years that DNA testing is coming and that it will change the way they breed animals (Scholtz & Nephawe, 2006). However, until six years ago there were no commercial DNA tests for quantitative traits available for beef cattle. In the case of pigs the DNA Halothane test was introduced some 15 years ago (Sellier, 2006) but most other tests were introduced recently.

Currently a small number of such tests are available, but it is anticipated that a greater number of such commercial tests will be offered in the near future. Because these tests will be commercially driven, breeders will be faced with increasing pressure to use these tests, without understanding the potential benefits if any (Scholtz & Nephawe, 2006).

Measurement of meat quality in live animals

In vivo Measurements

The evaluation of meat quality in livestock will enable breeders to more easily select for meat quality whereas the industry will be able to classify slaughter animals into quality groups. Methods based on real-time ultrasound image analyses have been developed for predicting intramuscular fat in both live pigs (Newcom *et al.*, 2002) and cattle. Besides this development there have not been any other major breakthroughs. The development of such methods for practical use will have to take ethical and animal welfare groups into consideration. For instance, will a technique that is based on the sampling of a muscle biopsy from the live animal be acceptable?

Gene Discovery

The identification of new genes has developed rather slowly in livestock species (Sellier, 2006). However, genomics is a rapidly evolving discipline and the success of searching for economically relevant genes in livestock may accelerate. Once such genes or markers have been identified, it may for example be possible to do the following on live animals: (1) select for tenderness, (2) sort animals to optimize quality and yield, and (3) predict tenderness, using this new technology.

Management for improved meat tenderness

Studies have indicated that U.S., Australian and Japanese consumers all identified tenderness as the single most important component of beef quality (Egan *et al.*, 2001; Koohmaraie *et al.*, 2005). Slaughter and post-slaughter protocols such as electrical stimulation, chilling and ageing have major influences on meat tenderness. Best practice carcass processing is therefore aimed at achieving optimum meat tenderness.

There are a number of ways to improve meat tenderness post slaughter and Koohmaraie *et al.* (2005) listed the following in order of their relative importance. They are:

- (1) Ensure a minimum amount of ageing time. Storing meat at 0 to 3 °C for an extended period of time allows for proper tenderization. A minimum time of 5 (pork), 10 (lamb) and 14 (beef) days of ageing will result in the majority of carcasses being tender.
- (2) Proper application of low voltage or high voltage stimulation for the correct period will result in improved meat quality.
- (3) Tenderness intervention processes such as marination, blade tenderization, etc.

However the production system and feeding regimen also influences meat tenderness. The following primary production processes (in order of importance) also influences meat tenderness (Koothamaraie *et al.*, 2005), and can be controlled or manipulated to some degree by the producer or feedlot operator:

- (1) A number of breeds have meat that is more tender than average. By selecting these breeds to produce beef, a small improvement can be obtained in average tenderness.
- (2) Aggressive implant strategies (over implanting) can reduce meat tenderness, so this should be avoided.
- (3) Stress on animals should be minimized within one week of slaughter.
- (4) Intramuscular injections result in a region of decreased tenderness in the meat surrounding the injection site. Injections should thus be subcutaneous or if it must be intramuscular, limited to less valuable areas such as the neck.
- (5) Animals with chronic health problems tend to have reduced meat tenderness.
- (6) Most research indicates that cattle should be fed a high-energy diet for a minimum of 75 days before slaughter for improved meat tenderness.
- (7) In cattle, castration of males should be before seven months of age to avoid reduced meat tenderness.
- (8) Age at slaughter for cattle must be less than 30 months.

Discussion

In only a few countries producers are awarded for meat quality, such as in the U.S.A. and Australia. However, in many countries consumers are not awarded for meat quality. The question is therefore, why should producers to increase meat quality? Consumers worldwide are getting more concerned about meat quality, with inconsistency in meat tenderness as one of the major problems (Koothamaraie *et al.*, 2005; SMART, 1994). Most consumers have indicated that they will consume more beef if they knew it was going to be tender. Thus, even though there may be no direct incentive for higher quality. Improved quality will stimulate beef consumption. This will lead to an increased demand for beef, and thus a growth in the market for beef. The challenge for commercial producers is therefore to supply beef and pork of consistently high meat quality.

Although the commercial producer and feedlot operator can influence some of the factors affecting meat quality, the abattoirs and processors also play a major role. Furthermore, the contribution of the seed stock industry should not be neglected. The genetic improvement of meat quality can only be achieved at this level. The commercial producers should therefore send clear signals to their bull and boar suppliers of what they want. Breed societies should ensure that their breeding objectives are addressing the needs of the commercial producer and the consumer, and that they move away from the overemphasis of artificial breed standards that do not have any impact on production efficiency or meat quality.

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