Prediction of Meat Quality

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ABSTRACT

Meat quality includes aspects of composition, especially fat content, as well as appearance, tenderness, flavour and juiciness. Factors cont[...] consumer perceptions of meat quality were discussed at the 1996 ICOMST Conference. Meat is eaten primarily as a quality and tasty food c[...] contributing to an enjoyable eating experience. Carcass composition and meat quality can be partly controlled by genetic and management m[...]

Carcass classification contributes little to the prediction of meat eating quality but may contribute to quality prediction to the extent that it ca[...] fat cover and red meat content. A classification system can predict the proportion of saleable meat or meat yield for which the producer shou[...] Against a background of health problems which may be associated with excessive fat intake, there is a range of meat fat cover and fat conte[...] by different consumers in a range of markets. Currently most meat carcasses apart from pigs are still classified/graded subjectively in most [...] Technology is still needed at reasonable cost for the prediction of carcass composition at slaughter. While in general meat flavour is not a p[...] most meats, some feeds have been identified as imparting less desirable flavours to some species, unless the problem is overcome by the a[...] desired flavour at retail or during cooking.

INTRODUCTION

At the 1996 conference, Issanchou (1996) commented on consumer expectations and perceptions of meat and meat product quality and pointe[...] on occasions these may contrast with the objectively measured data. This highlights the importance of taking into account consumer expect[...] perceptions when marketing quality products. Meat is mainly eaten as a quality and tasty food component contributing to an enjoya[...] experience. In the process meat contributes protein, minerals (especially iron and zinc), vitamins and as a source of mono- and polyunsatu[...] acids (NRC, 1988). The other contributors to this session will cover quality factors affecting tenderness and texture. This paper will conc[...] methods for placing before consumers meat products containing an acceptable level of fatness against a background that this level can be qui[...] between different consumer groups and for different meat products. Several strategies are available down the chain between productio[...] consumer to result in a meat product of the desired fat content being placed before the consumer.

The genetic strategy is to select a breed and growth pattern which produces cuts of the best size and fat content for an identified market. S[...] content can be further modified by genetic selection (Kirton *et al.*, 1997a). Animals can be grown to the appropriate size for the genot[...] slaughtered before they reach the fattening phase where fat cover can be excessive. Within a genotype, it may be necessary to manage ani[...] different sexes (male, castrate, female) differently, and slaughter at different final weights in order to meet target fat levels. After [...] classification can sort the carcasses containing different levels of fatness into groups suitable for different end markets. Finally, animals w[...] slaughter with excessive carcass fatness can be have the surplus fat trimmed off to make the cuts or other products acceptable - a waste of bo[...] used to lay down the fat and the labour needed to chop it off. Many of these issues have been summarised in Wood & Fisher (1990) and in [...] Dutson (1997).

CONTROLLING MEAT FATNESS

The genetic approach

It is now well established that there are breed/genotype differences in carcass fatness largely related to mature size at slaughter. Animals [...] mature size are likely to be less mature and therefore leaner when slaughtered at the same time (or weight) as animals of smaller m[...] (McClelland & Russell, 1972; McClelland *et al.*, 1976, Kempster *et al.*, 1982). This helps explain why European beef breeds (e.g. [...] Simmental, Limousin) are leaner than the traditional British beef breeds (Angus and Hereford) and lambs from breeds such as the Southdown [...] than lambs from breeds such as the Suffolk when slaughtered at the same age.

Published heritability figures covering sheep, cattle and pig fat and muscle indicators (see summary by Kirton & Morris 1989; Bass et [...] indicate considerable scope for breeding animals of desired fat content. Heritability coefficients for meat quality attributes were reported by [...] al. (1996). For tenderness, these coefficients were in the order of 0.22-0.27 for beef. Results reviewed in that paper indicated that in shee[...] variations in calpastatin were positively associated with 36% of the variation in shear force and negatively associated with 55% of the v[...] initial tenderness. For beef cattle, post-rigor calpastatin was found to be highly heritable (0.65), negatively associated with average daily [...] intramuscular fat content, and positively associated with % retail product yield. Clarke *et al.* (1996) have also reported breed, strain and sire [...] in shear force and ultimate pH and their association with longissimus muscle depth in sheep. They also reported greater tenderness in a bo[...] selected Romney line compared with an unselected control line.

summary of selection experiments on sheep, cattle and pigs (Kirton *et al.*, 1997a) has shown that where applied, selection based on ultrasonically termined fat depths has been able to increase or decrease the fat content of the progeny of selected male animals in the desired direction. More cently, Kirton *et al.* (1997b) reported that the progeny of rams selected for longissimus muscle cross sectional area have been shown to have both rger cross sectional areas as anticipated, but also larger longissimus muscles as a proportion of dissected muscles from the leg, shoulder plus the ngissimus and psoas from the loin and rack. The dissected muscle in this trial comprised about 75% of total carcass muscle providing a good presentation of muscle content. Indications are that more widespread male screening is likely to identify animals that diverge further from the breed ean than those identified to date. In future, animal breeding programmes based on the identification of live animals and their composition directly or rough progeny testing, will be required to produce livestock of the composition required by consumers. Lambs with more muscle also have less fat. ne results collectively suggest scope for selection of animals of desired fatness levels and meat quality.

ne most important gene variants such as the callipyge in sheep (Koohmaraie *et al.*, 1995) and double muscling (Culard, Doppellender) in cattle rthur, 1995) primarily increase muscle content, but at the same time lower the fat content of the affected carcasses (Koohmaraie *et al.*, 1995; Shahin Berg, 1985). However, whereas the meat from double muscled cattle is, if anything, more tender (Arthur, 1995), in the case of callipyge sheep the eat from double muscled animals appears to be tougher than from others lacking this characteristic (Koohmaraie *et al.*, 1995). Thus whereas changes double muscled cattle seem to be in the direction of improved meat quality, the advantage of lower fat content of the callipyge sheep seems to be fset by the disadvantage of less tender meat providing an opportunity for meat scientists to look for creative solutions. In pigs, a single gene is lieved to be associated with a high meat and low fat carcass content. The undesirable side effect associated in this case is the production of pale, soft, udative (PSE) pork associated with lowered meat quality.

ne future contributions to genetic solutions for reducing carcass fat and improving meat quality may come from gene mapping and gene markers, a latively new and developing field of science discussed by the genetic co-authors in Kirton *et al.* (1997a).

nimal management and sex

hereas nutrition can play a large role in controlling the fat content in the bodies of monogastric animals such as pigs (and man), there is a large body data showing it is difficult to alter the body/carcass composition of ruminants through nutrition. This situation was summarised by Reid *et al.* 968). Recently, Williams *et al.* (1995) reported a computer simulation involving cattle subjected to a variety of nutritional combinations showed that stems produced lean carcasses where steers gained a greater proportion of final slaughter weight over long durations of growth restriction. It has also en shown in lambs that composition is very difficult to alter nutritionally during the first 9 months of growth over the first winter and following ring in New Zealand. However, if the lowered nutrition is continued after this period, it appears that the fat content of lamb carcasses may be duced nutritionally (Binnie *et al.*, pers comm., paper in preparation).

everal reviews have shown that carcass composition differs between the different sexes with males (larger mature size) being leaner than females at ny carcass weight and castrate males being intermediate in fat content (Rhodes, 1969; Field, 1971; Seideman *et al.*, 1982; Bass *et al.*, 1990; Purchas, 991). However, in contrast to the situation for ruminants, castrate male pigs may be fatter than females (Evans & Kempster, 1979) although entire nale pigs will be leaner than females as for ruminants (Wood *et al.*, 1979; Wood & Riley, 1982). Purchas (1991) reviewed the effects of sex on other spects of meat quality and reported that the cooked meat from older entire male pigs may produce "boar odour" and the meat from older bulls may be ougher than that from similar aged steers or heifers.

arcass classification

he link between the producer and processor in the meat industry is usually through carcass classification which can indicate consumer desired aspects uch as cut size and fat cover/content and may be related to the carcass payment system. Several recent texts (Kempster *at al.*, 1982; Jones 1995; watland, 1995) have reviewed aspects of carcass classification systems, many of which are still largely subjective, but with increased emphasis being laced on more objective systems. Pig carcass classification systems lead the way in this regard. Objective classification systems have additional dvantages over subjective systems including the possibility of the return of information to the supplier, such as a plot of carcass weights against the fat neasure used. This information can provide a useful management tool to the supplier indicating the liveweight/carcass weight levels at which the class f animal being run starts to produce unwanted levels of carcass fatness. After slaughter, the information can be used for sorting carcasses into groups nost suitable for a particular end use or customer.

Vorldwide, there has been efforts to develop objective systems for predicting the carcass composition of pigs, cattle and sheep more accurately and vith greater consistency than subjective methods, at an affordable cost and at the normal slaughter speeds. More than 30 techniques for estimating live nimal and/or carcass composition were reviewed by Topel & Kauffman (1988) and the texts (Kempster *et al.*, 1982; Jones, 1995; Swatland, 1995) over some of the methods used or proposed for future use. The most accurate methods available such as CT scanning and MRI are currently far too xpensive for use on-line and unable to allow carcass throughput at slaughter speed. Cheaper x-ray technology such as duel-energy x-ray bsorptiometry (DEXA) is now being investigated (Mitchell *et al.*, 1996). It is being used on smaller carcasses from pigs and sheep for research urposes.

Optical probes are in widespread use for pig carcass classification in Europe with up to 15 probe measurements being taken per carcass in Denmark Forrest, 1995). Neural network techniques may be used to allow reduction of the number of probe measurements on each carcass. A comparison taking one probe measurement per carcass on lamb carcasses using one optical (Hennessy Grading Probe) and 2 manual (AUS-Meat Sheep Probe; FTC Lamb Probe) probes giving electronic tissue depth readings showed all reached a similar level of accuracy in predicting carcass fat and lean (water and protein) content (Kirton *et al.*, 1994). If more probe readings could be taken robotically on each carcass, greater predictive accuracy may be achieved as for pigs. The cost of currently available technologies which can assist with carcass classification compared to present subjective systems has resulted n a slow uptake of objective technologies except for pig carcasses where the presence of the skin and absence of hair or wool makes measurements for he prediction of carcass composition/yield much easier.

Flavour

Research on meat flavour and odour problems was reviewed by Gray *et al.* (1994). Most consumers consider meat has a desirable flavour wit cases the preferred flavours relating to the products they normally eat. Those accustomed to eating grain fed beef prefer this product to grass while those accustomed to grass fed beef may prefer this to the blander grain fed beef considered to have less flavour. Those accustomed mutton or goat meat find these very acceptable while in many countries the flavour and cooking smells from these meats is considered un (Gray *et al.*, 1994). Consumers in New Zealand and in most countries to which lamb is exported do not notice any flavour or odour associ young male lambs and in fact local research could detect no flavour or odour problems with the meat from older male sheep when compared meat from similar aged females (Kirton *et al.*, 1983). By contrast, some US research has detected odour/flavour problems with the meat fro ram lambs (Siedeman *et al.*, 1982) which may be associated with a different fatty acid profile (Busboom *et al.*, 1981) and in particular branch fatty acids. Wong et al. (1975) identified 4-methyloctanoic acid as a contributor to the distinctive flavour of sheepmeat. Young & Braggi identified 3-methylindole as having the highest correlation (0.53) with sheepmeat odour in their study.

Although Reineccius (1979) and Gray *et al.* (1994) reviewed the contributions from diet to off-flavours/odour problems, Sink & Caporaso (1 Field *et al.* (1983) have suggested the possibility that diet can be used to impart desirable flavours to sheepmeat. This possibility has suggested for beef where a negative effect of pasture has been noted relative to grain fed beef (Melton, 1983). While Gray *et al.*, 1994) report feed trials involving legumes recording that this herbage contributes to less desirable flavour (more intense; off flavours), some work has detect this and one trial seldom cited (Nixon, 1981) reported that grass pasture produced less acceptable lamb cooked flavour than animals g legumes. Obviously, more detailed flavour research to isolate the components contributing to the different flavours is still required.

Summary

This paper has reviewed factors affecting carcass composition with special reference to fat content which can be used as one component quality. Control of factors known to influence carcass fatness can be used to predict one aspect of meat quality after these factors are manip produce the desired end result. The genetic and management techniques to be used for production of more muscular, less fat animals are no and being further clarified. Objective carcass classification systems such as those used for pig carcasses which predict carcass fatness are stepping stone in this regard. However, currently most carcass classification systems used for cattle and sheep are subjective because su accurate and cost effective objective systems are not readily available. Although factors are known which can affect meat flavour, many of the compounds involved are still to be identified.

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