Comparison of the eating quality of fourteen beef muscles

K R Matthews, D B Homer and C C Warkup

Meat and Livestock Commission, PO Box 44, Winterhill House, Snowdon Drive, Milton Keynes MK6 1AX, United Kingdom.

Background

Most experiments involving sensory analysis in beef use only a limited number of muscles. Relatively little work has been carried out comparing the eating quality of individual muscles within a carcase. Those published have largely been carried out in American beef animals (for example McKeith *et al*, 1985; Carmack *et al*, 1995; Shackelford *et al*, 1995) and the results of these are not necessarily applicable to animals finished in Great Britain (GB).

In addition, it is often assumed that the eating quality of one muscle measured in the carcase (often the *Longissimus thoracis et lumborum*) indicates the eating quality of all the muscles in the carcase relative to other animals. This assumption, whilst forming the basis for the conclusions drawn from many trials, has not been extensively tested.

Objectives

The main objective of this study was to compare the eating quality of a selection of beef muscles to provide information to support the use of different muscles in meat products. A secondary objective was to test the assumption that the rated quality (in particular tenderness) of one muscle in a carcase is a reliable indicator of the quality of other muscles of the same animal.

Methods

Beef carcases were selected from three abattoirs to give a total of fifteen representing a range of breed types. Carcases covered the EC fat classes 3 to 4H and were of conformation class R or O+ (fat class 4 and conformation class O being divided into two sub classes in GB). Carcases were chilled such that muscles did not fall below 10°C within 10 hours of stunning. They were quartered 48 hours after slaughter and the left sides transported to a cutting facility. On arrival, fourteen muscles were taken from the left side of each carcase by seam butchery. These are listed below with the common name of the cut of which they normally form a part in GB.

Psoas major (Psoas)	fillet	*Tensor fasciae latae*	rump
Longissimus lumborum	loin (hind quarter)	*Gastrocnemius*	leg
Semimembranosus	topside	*Longissimus thoracis*	loin (fore quarter)
Semitendinosus	silverside	*Triceps brachii*	jacobs ladder
Biceps femoris	silverside	*Infraspinatus*	feather blade
Rectus femoris	thick flank	*Supraspinatus*	blade
Gluteus medius	rump	*Rhomboideus*	crest

These were vacuum packed and held at 3°C to complete a seven day ageing period. Steaks (20 mm thick) were cut from each muscle, vacuum packed, blast frozen and held at -30°C. Steaks were thawed at 3°C for 72 hours and then grilled for 5 minutes each side under a gas grill. Cubes of lean were subjected to sensory panelling using MLC's panel trained according to British Standard 7667 (BSI, 1994). Samples from seven muscles of the same carcase were panelled in a single panel session and the other seven muscles from the same carcase in another session carried out at the same time but with a different set of panellists. Panellists assessed the samples for initial juiciness, muscle fibre tenderness, beef flavour, abnormal flavour, sustained juiciness, residual connective tissue and overall acceptability. Each attribute was rated from 1 to 8 where 1 was low (none for residual connective tissue) and 8 was high.

Data were analysed by analysis of variance using terms for session, carcase and muscle to establish the size of muscle differences. Multivariate analysis was carried out to identify groups of muscle in terms of overall eating quality and correlations between the muscles to indicate the predictive ability of the eating quality of one muscle for the eating quality of others in the same carcase.

Results and Discussion

Table 1 shows the least squares means by muscle for the sensory traits evaluated. It can be seen that the *Psoas* was significantly more juicy (both initial and sustained) than any of the other muscles, with the *Semimembranosus* and *Rhomboideus* being rated the lowest. This is broadly in line with the results of Carmack *et al.* (1995) who evaluated 10 of the fourteen muscles studied here, with the main exception being the *Infraspinatus* which they found to be more juicy than the *Psoas*. McKeith *et al.* (1985) and Shackelford *et al.* (1995) both found *Psoas* to be middle ranking for juiciness and also found *Biceps femoris* to be more juicy than seen here (relative to the other muscles).

As would be expected, the *Psoas* was also significantly more tender (and had lower residual connective tissue) than all other muscles in agreement with McKeith *et al.* (1985), Carmack *et al.* (1995) and Shackelford *et al.* (1995). Muscles from the topside and silverside (*Semimembranosus, Semitendinosus* and *Biceps femoris*) and the blade and crest (*Supraspinatus* and *Rhomboideus*) had relatively low levels of tenderness, perhaps surprisingly in the case of the former group since they are commonly roasted dry in Britain. The remaining muscles had similar, intermediate, levels of tenderness. The ranking of muscles was, again, similar to that of McKeith *et al.* (1985), Carmack *et al.* (1995) and Shackelford *et al.* (1995) with the exception that McKeith *et al.* (1985) found *Triceps brachii* to be much lower down the ranking. The fact that residual connective tissue mirrored muscle fibre tenderness suggests that differences in tenderness between muscles are due to differences in the amount of connective tissue present. There is some evidence, however, that differences between muscles are, at least partly, due to differences in the extent to which ageing occurs (Negishi and Yoshikawa, 1993).

Most of the muscles had similar beef flavour scores, in the range 4.5 to 5.0, with *Psoas* again having the highest score at 5.1, but the *Semitendinosus* and *Rhomboideus* had scores significantly lower than the rest. The results of McKeith *et al.* (1985) Carmack *et al.*

(1995) and Shackelford *et al.* (1995) differ from this and each other. For example, Shackelford *et al.* (1995) found *Psoas* to have the second lowest beef flavour score (next to *Infraspinatus*) whilst McKeith *et al.* (1985), in agreement with the findings presented here, found *Psoas* to have the highest flavour desirability. This is not altogether surprising as the perception of flavour differs widely. In particular, Americans seem to prefer the flavour of grain finished animals and the British consumer that of grass finished cattle. It might have been expected the abnormal flavour scores would be a mirror image of the beef flavour scores. This, however, was not the case with *Rectus femoris* and *Infraspinatus* standing out as having higher abnormal flavour scores than the other muscles.

Multivariate analysis showed that muscle could be divided into three main groups (excluding fillet) characterised by juiciness and tenderness (average or low) and flavour characteristics (average or abnormal), independent of location in the carcase.

Correlations between the muscles were carried out correcting for session and carcase. Although there were a few significant correlations between pairs of muscles (a correlation of >0.5, $p \leq 0.05$), these were inconsistent and generally correlations were small. It is therefore inadvisable to use one muscle in the carcase to attempt predict the eating quality of the other muscles in the carcase and important in meat quality research that as many as possible of the muscles of importance are represented.

Conclusions

The *Psoas* stood out as being more tender and juicy than the other muscles which fell into three groups (not related to the position of the muscles within the carcase). One group was about average for the main traits whilst one was characterised by low tenderness and juiciness. The third consisted of two muscles characterised by poor flavour.

Correlations in eating quality traits between the muscles were low indicating the quality of one muscle cannot reliable used to predict that of others in the same carcase.

References

BSI (1994). Assessors for sensory analysis. Part I. Guide to the selection, training and monitoring of assessors. No. 7667., British Standards Institution, Milton Keynes, UK.

Carmack, C.F., Kastner, C.L., Dikeman, M.E., Schwenke, J.R. and Garcia Zepeda, C.M. (1995). "Sensory evaluation of beef-flavor-intensity, tenderness, and juiciness among major muscles." Meat Science **39**: 143-147.

McKeith, F.K., DeVol, D.L., Miles, R.S., Bechtel, P.J. and Carr, T.R. (1985). "Chemical and sensory properties of thirteen major beef muscles." Journal of Food Science **50**(4): 869-872.

Negishi, H. and Yoshikawa, S. (1993). "The effects of beef muscle variety on ageing indices." Animal Science and Technology **64**(12): 1168-1177.

Shackelford, S.D., Wheeler, T.L. and Koohmaraie, M. (1995). "Relationship between shear force and trained sensory panel tenderness ratings of 10 major muscles from Bos indicus and Bos taurus cattle." Journal of Animal Science **73**(11): 3333-3340.

Table 1. Least square means for sensory traits of fourteen beef muscles

Muscle	Initial juiciness	Muscle fibre tenderness	Beef flavour	Abnormal flavour	Sustained juiciness	Residual connective tissue	Overall Acceptability
Psoas major	6.2	7.0	5.1	1.6	5.5	1.7	6.3
Longissimus lumborum	5.4	4.6	4.7	1.5	4.6	3.3	4.7
Semimembranosus	4.8	3.2	4.5	1.8	4.1	4.9	3.3
Semitendinosus	4.9	3.6	4.2	1.7	4.3	4.5	3.7
Biceps femoris	5.1	2.7	4.8	1.8	4.3	5.9	2.8
Rectus femoris	5.5	4.6	4.7	2.0	4.6	3.3	4.5
Gluteus medius	5.4	4.4	5.0	1.8	4.6	3.6	4.6
Tensor fasciae latae	5.1	4.5	4.7	1.7	4.5	3.7	4.6
Gastrocnemius	5.1	5.4	4.7	1.6	4.5	2.9	5.0
Longissimus thoracis	5.2	4.8	4.8	1.7	4.3	3.3	4.8
Triceps brachii	5.6	4.7	5.0	1.6	4.9	3.5	4.8
Infraspinatus	5.7	5.4	4.7	2.1	5.0	3.2	5.0
Supraspinatus	5.5	4.0	5.0	1.7	4.8	4.1	4.3
Rhomboideus	5.0	2.4	4.1	1.6	4.4	5.9	2.8
95% LSD	0.42	0.56	0.32	0.31	0.38	0.55	0.51
Significance	***	***	***	*	***	***	***