EFFECT OF ACCOMMODATION SYSTEM ON COLOUR AND QUALITY OF *LONGISSIMUS DORSI* AND *EXTENSOR CARPI RADIALIS* MUSCLES OF STEERS

J. Rogalski[1]*, T. Moreno[2], P.G. Dunne[1], F.J. Monahan[3], P. French[4] and A.P. Moloney[1,5]

[1]Meat Technology Department, Teagasc, Ashtown Food Research Centre, Ashtown, Dublin 15, Ireland, [2] Centro de Investigaciones Agrarias de Mabegondo, Apartado 10, 15080 A Coruña, Spain, [3] Department of Food Science, University College Dublin, Dublin 4, Ireland, [4] Teagasc, Moorepark Research Centre, Fermoy, Co. Cork, Ireland, [5] Teagasc, Grange Research Centre, Dunsany, Co. Meath, Ireland.
E-mail: jaroslaw.rogalski@teagasc.ie

Keywords: beef, steers, accommodation, housing, muscle, colour

Introduction

The factors that affect beef quality have been widely studied and can be broadly categorised as either intrinsic, e.g. breed, gender, age, muscle, or extrinsic. Extrinsic factors relate both to environmental ('on-farm') conditions under which animals are produced, e.g. nutrition, accommodation, climate and welfare, and also post-mortem technological factors that affect muscle tissue properties and thus meat quality, e.g. electrical stimulation, chilling rate and packaging. Currently, other than nutritional effects, there is a paucity of information with regard to effects of extrinsic 'on-farm' factors which may cause variation in meat quality of cattle. Foremost among these factors is the accommodation system under which cattle are housed.

In Ireland, approximately 38% of cattle are slaughtered annually between January and May and the majority of these cattle are finished indoors, usually in 'conventional' slatted floor accommodation (SLA). Provision of such accommodation can represent a substantial capital and overhead cost and thus, cheaper alternatives such as out-wintering pads (OWP) have been examined. From an animal welfare perspective, straw bedding (STR) is often perceived to be preferable to a slatted floor. When operated optimally, these accommodation options differ in environment, space allowance and floor type, all of which could influence beef quality from a consumer perspective. Since there is a deficit of information concerning this issue, the objective of this study was to document the effect of type of cattle accommodation on the quality of two muscles.

Materials and Methods

Forty-five Charolais crossbred steers were blocked on bodyweight and within block accommodated at random either outside on OWP at 18m^2/head or inside on SLA at 2.5m^2/500kg bodyweight or on STR at 4m^2/500kg bodyweight . Animals on each treatment were penned in groups of five and offered a total-mixed ration (500g of concentrates dry matter (DM) and 500g of grass silage DM/kg total DM) *ad libitum*. Post-slaughter after a 132-day feeding period, carcass weight and fat score were recorded. Two days post-mortem, pH, colour and drip loss of *M. longissimus dorsi* (LD) and *M. extensor carpi radialis* (ECR) were measured. Following vacuum storage at <4°C for a further 12 days, colour was again measured and samples stored frozen for subsequent assessment of tenderness (as Warner-Bratzler shear force, WBSF), organoleptic characteristics and lipid content. Data were analysed using models appropriate to a randomised complete block or a randomised block split plot design, as required. Composition and pigment concentrations were measured in samples collected at 2days post-mortem and stored frozen.

Results and Discussion

Carcass weight averaged 351, 362 and 372 (s.e.d. 6.63) kg ($P<0.05$) for SLA, STR and OWP, respectively. Type of accommodation had no effect on the redness, saturation or hue of either LD or ECR muscles at 2 or 14 days post mortem (Table 1). Type of accommodation did not affect drip loss, shear force or lipid content of either muscle examined (Table 1) or the sensory attributes of tenderness, texture, flavour, juiciness, chewiness or acceptability of LD muscle (data not shown). As previously observed (Dunne *et al.*, 2005), the ECR muscle was less red and had lower colour intensity (saturation) but also had lower drip loss, less lipid and required greater shear force than LD muscle (Table 1). The pH of ECR muscle was higher ($P<0.05$) for animals accommodated on OWP compared to that for animals accommodated on SLA or STR, while LD muscle from OWP was darker at 2 days post-mortem than LD from animals accommodated on STR. The effect of muscle on haem pigments approached significance ($P=0.065$) but there was no effect of accommodation system.

In general, there were no important effects of accommodation system on any meat quality characteristic; muscle was a more important source of variation. Previously, Jensen and Oksama (1996) reported that accommodation system influenced colour (lightness, hue and saturation), pigmentation and shear force of LD from Danish Friesian and Danish Jersey young bulls. However, in their study loose-housed and tie-stall bulls were compared. Thus, effects may have been mediated by differences in the level of physical activity of both groups. Dunne *et al.*, (2005) reported that exercise increased redness of ECR but not LD. In the present study, by contrast, LD of OWP steers was darker at 2days post-mortem which may relate to metabolic differences mediated by physical activity. The OWP steers had more space and thus more opportunity at least, if not more inclination, to exercise although definitive conclusions are difficult to draw

in this regard. Any marginal differences in LD colour were absent at day 14. This was as expected since during ageing mitochondrial decay leads to a reduction in competition for available oxygen by mitochondrial respiratory enzymes. Coupled with structural changes, this leads to increased penetration by oxygen and a deeper oxymyoglobin layer (Hood, 1980), thus attenuating any treatment differences present at day 2. Differences in meat quality indices due to muscle rather than treatment variability, as observed in the present study are not surprising since muscles, particularly those chosen here, are known to exhibit contrasting histochemical, biochemical and metabolic characteristics due to their location, and thus function within the animal (Klont *et al.*, 1998).

Tenderness is a critical component of eating quality, particularly for beef. While there remains some conjecture regarding the exact molecular basis for post-mortem tenderisation of beef, it is generally accepted that genetic factors and post-slaughter technologies have a greater effect on tenderness than 'on-farm' environmental factors, such as accommodation system (Tatum *et al.*, 1999). Tenderness differences between LD and ECR most likely relate to compositional differences, particularly in collagen content, reflecting differences in anatomical location and muscle function but also histochemical and biochemical differences (Klont *et al.*, 1998).

Table 1: Colour (2 and 14 days), pH and meat quality indicators of *M. longissimus dorsi* (LD) and *M.extensor carpi radialis* (ECR) of steers accommodated in slatted-floor housing (SLA), in straw-bedded housing (STR) or on out-wintering pads (OWP).

Variable	LD			ECR			SED	Significance	
	SLA	STR	OWP	SLA	STR	OWP		Muscle	System
Colour (2d)									
Lightness	36.2^{ab}	37.5^{b}	35.6^{a}	40.3^{c}	39.3^{c}	39.2^{c}	0.73	***	NS [1]
Redness	13.8	14.1	13.9	13.0	13.0	13.0	0.47	***	NS
Hue	29.4	30.2	29.0	32.2	31.4	31.3	0.72	***	NS
Saturation	15.8	16.3	15.9	15.4	15.3	15.2	0.53	*	NS
pH	5.56^{a}	5.56^{a}	5.56^{a}	5.81^{b}	5.81^{b}	5.90^{c}	0.030	***	* [2]
Colour (14d)									
Lightness	37.2	36.7	36.5	37.3	36.7	36.4	0.62	NS	NS
Redness	16.4	16.8	16.5	15.3	15.0	14.6	0.53	***	NS
Hue	30.0	29.6	29.8	30.8	30.3	30.5	0.61	***	NS
Saturation	19.0	19.3	19.0	17.8	17.4	17.0	0.55	*	NS
Drip loss (g/kg)	15.7	14.3	18.4	4.9	5.1	5.2	1.76	***	NS
WBSF (N)	26.8	27.3	25.9	58.0	60.1	64.7	2.88	***	NS
Lipid (g/kg)	31.7	30.5	28.6	9.4	7.9	8.7	3.07	***	NS
Pigments (mg/g)	7.02	7.24	7.53	6.56	6.91	6.57	0.570	NS [3]	NS

[a,b,c] Within rows, means assigned different superscripts differ significantly (P<0.05).
[1] Muscle × system (P=0.04), [2] Muscle × system (P=0.07), [3] Muscle P=0.065

Conclusions

Under the conditions of the study, compared to conventional indoor housing, accommodating cattle on OWP had a minor transient effect on beef colour and no impact on beef lipid content or eating quality, simulated by WBSF. No evidence emerged of an effect of type of indoor housing on major meat quality characteristics.

Acknowledgements

J. Rogalski was in receipt of a European Union Marie Curie Fellowship.

References

Dunne, P.G., O'Mara, F.P., Monahan, F.J., French, P. and Moloney, A.P. (2005). Colour of muscle from 18-month-old steers given long term daily exercise. Meat Science, 71: 219-229.

Hood, D.E. (1980). Factors affecting the rate of metmyoglobin accumulation in pre-packaged beef. Meat Science, 4: 247-265.

Jensen, L.R. and Oksama, M. (1996). Influence of different housing systems on carcass and meat quality in young bulls. Proceedings of the 42nd ICoMST, p.436-437.

Klont, R.E., Brocks, L. and Eikelenboom, G. (1998). Muscle fibre type and meat quality. Meat Science, 49:S219-S229.

Tatum, J.D., Belk, K.E., George, M.H. and Smith, G.C. (1999). Identification of quality management practices to reduce the incidence of retail beef tenderness problems: development and evaluation of a prototype quality system to produce tender beef. Journal of Animal Science, 77:2112-2118.