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BRIEF COMMUNICATION: Effect of sex on colour and pH of chilled lamb loins

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Keywords: marbling; intramuscular fat; lamb; meat quality.**INTRODUCTION**

With more chilled lamb being exported from New Zealand, there is interest in factors affecting the quality of the chilled product. Two key factors are ultimate pH and the redness of the meat when on display for sale. The possible effect of the sex of the lamb on these quality traits is of interest to the industry (Meat and Wool New Zealand, 2006). A number of studies have reported non-significant differences between ewe and ram lambs at moderate carcass weights of approximately 18 kg, for pH and colour measured within 24 hours post-slaughter (Dransfield *et al.*, 1990; Moore & Duganzich, 1985; Okeudo & Moss, 2008). On the other hand, Bickerstaffe *et al.* (2000) and Johnson *et al.* (2005) reported significant differences in pH, while Johnson *et al.* (2005) reported that meat from ram lambs had poorer initial colour relative to ewe lambs at moderate carcass weights. None of these studies considered the effect of sex on meat colour in lamb that has been long term chill stored as occurs when lamb is exported to the United Kingdom prior to retail sale.

This brief communication investigates sex differences in pH and the colour of lamb loins processed after chilled storage for eight weeks.

MATERIALS AND METHODS

Data collected in 2006, 2007 and 2008 were available from a progeny test of sires of a composite breed consisting of Suffolk, White Suffolk and Poll Dorset genotypes. The ewe and ram lambs in each lamb crop were reared in the same environment and slaughtered on one day in late January at approximately five months of age. A different plant was used in 2007 to that used in 2006 and 2008. After slaughter the carcasses were electrically stimulated and aged following accelerated conditioning and aging criteria (Crystall, 1989). A total of 5,628 lambs were assessed.

On the day following slaughter boneless loins were collected, vacuum packed, and stored at -1°C for eight weeks. After eight weeks chilling ultimate pH was measured using a Sensorex spear-tip probe calibrated using buffer standards.

Three 2 cm thick transverse slices of loin were cut from within the loin sample, placed on small plastic trays, wrapped using semi-permeable film and stored at 4°C. Colour was measured using the CIE

L*,a*,b* scale with a Minolta Chromameter. Colour was measured at 24 hour intervals for up to ten days from the time of the initial slice. Only colour CIE a* values, a measure of redness, at 96 hours are reported here as a representative measurement of prolonged aging (Johnson *et al.*, 2008).

Carcass weight, pH and CIE a* values were analysed using the GLM procedure in SAS (SAS, 2004), to estimate sex differences. The models included fixed effects of sex, year, and sire, with carcass weight fitted as a covariate in the pH and CIE a* models. In an additional model analyzing CIE a*, pH was also fitted as a covariate. The relationship between pH and CIE a* with carcass weight within sex, were investigated using the regression procedure in SAS (SAS, 2004).

RESULTS

Carcasses weights ranged between 9 kg and 28 kg with less than 1% being heavier than 22 kg. Adjusted, carcass weights are shown in Table 1. In years 2007 and 2008 carcass weight was similar but 2006 had lighter carcass weights.

The pH of the ram loins was significantly higher ($P < 0.001$) than that of the ewe loins in all years (Table 1). CIE a* was significantly higher ($P < 0.001$) for ewe lambs relative to ram lambs in all years, when pH was not included as a covariate in the model. After inclusion of pH in the model the differences between ewe and ram lamb loins were only significant ($P < 0.001$) in 2006 and 2007. Despite the sex effect generally being significant, it only explained 1.9% of the variation in CIE a* when pH was not included in the model, and less than 1% of the variation when pH was included. When fitted in the model, pH explained 32% of the variation ($P < 0.001$) in CIE a*.

Relationships between carcass weight and the traits of pH and CIE a* determined through regression analysis are shown in Table 2. Despite a low R^2 (coefficient of determination) value, in 2006 and 2008 there was a significant negative relationship between pH and carcass weight in both sexes, with lighter carcass weight lambs tending towards an elevated pH. In 2007 there was no relationship between pH and carcass weight for either sex. Although the R^2 values were low, there was a positive relationship between carcass weight

TABLE 1: Sex differences between years in carcass weight, and the pH and CIE a* value of lamb *M. longissimus dorsi* muscle after chilled storage for eight weeks. SED = Standard error of difference.

Year	Sex	Carcass weight (kg)	pH	CIE a* ¹	CIEa* ²
2006	Ewe	12.9 ^a	5.79 ^a	19.2 ^a	19.3 ^a
	Ram	13.2 ^a	5.83 ^b	18.8 ^b	19.0 ^b
	SED	0.09	0.01	0.06	0.06
2007	Ewe	15.8 ^b	5.62 ^c	20.7 ^c	20.4 ^c
	Ram	16.8 ^c	5.65 ^d	20.2 ^d	20.0 ^d
	SED	0.10	0.01	0.06	0.05
2008	Ewe	15.4 ^b	5.84 ^b	17.5 ^e	17.9 ^e
	Ram	16.5 ^c	5.95 ^e	16.9 ^f	17.6 ^e
	SED	0.09	0.01	0.07	0.06

Means in the same column with different superscript letters are significantly different ($P < 0.001$).

¹Unadjusted.

²Adjusted for pH.

TABLE 2: Intercept and slope of the relationship between carcass weight and pH, and carcass weight and CIE a* of lamb *M. longissimus dorsi* muscle after chilled storage for eight weeks across three years.

Year	Sex	Intercept	Slope	R ²	Significance ¹
Carcass weight vs pH					
2006	Ewe	28.8	-2.75	0.05	***
	Ram	31.9	-3.21	0.08	***
2007	Ewe	19.4	-0.62	0.00	NS
	Ram	18.7	-0.33	0.00	NS
2008	Ewe	29.8	-2.45	0.03	***
	Ram	21.6	-0.89	0.01	*
Carcass weight vs CIE a*					
2006	Ewe	7.6	0.28	0.06	***
	Ram	7.0	0.33	0.07	***
2007	Ewe	12.2	0.18	0.01	**
	Ram	10.3	0.32	0.02	***
2008	Ewe	7.4	0.46	0.07	***
	Ram	8.0	0.49	0.09	***

¹Significance of slope differing from zero.

and CIE a* in all three years for each sex, with heavier carcass weight lambs tending to have higher CIE a* values. This is desirable effect.

DISCUSSION

This study supports the findings of Bickerstaffe *et al.* (2000), and Johnson *et al.* (2005), that the pH of the loin of ram lambs was significantly higher than the loin of ewe lambs after eight weeks of

chilled storage. Although significant, the sex effect only explained a small proportion of the variation in pH. Further analyses of this data set have shown that more of the variation in pH is explained by sire and year than by sex (P.L. Johnson, Unpublished data). An interesting observation was that for the main carcass weight range of 9 to 22 kg assessed in this study, lighter weight lambs tended to have an elevated pH. This relationship was observed in both sexes in two of the years. Further investigation is required to evaluate whether this trend continues over heavier carcass weights weighing more than 22 kg to ascertain whether heavier carcass weight lambs have a lower pH relative to moderate and low carcass weight lambs. There are also the potentially confounding effects of carcass and the time of year when the lambs are slaughtered coupled with the onset of puberty.

Although there were significant differences between the sexes for measured CIE a*, the difference was not significant in 2008 after adjustment for pH. Regardless of whether the CIE a* values were adjusted for pH, sex alone only explained a very small proportion of the variation in the redness of the loin with pH explaining more of the variation than sex. As with the pH data further analyses of the CIE a* data have shown that more of the variation in CIE a* values is explained by sire and year than by sex (P.L. Johnson, Unpublished data).

The relationship between carcass weight and the redness of the loin is such that redness improved with increasing carcass weight, within the range of the assessed carcasses. On farm factors such as nutritional stress, and pre-slaughter handling are known to impact on pH (Ferguson & Warner, 2008; Jacob, 2003), but were not fully recorded in this study so no inferences can be drawn as to any role they may have played.

CONCLUSION

While differences between ewe and ram lamb loin cuts in pH and CIE a* at 96 hours following chilling for eight weeks were evident, the amount of variation in these traits explained by sex was very low. For the main weight range of 9 to 22 kg in the assessed carcasses slaughtered in mid-summer, there would be no advantage in discriminating

against ram lambs for producing lamb for chilled export on the grounds of differences in either the pH or redness of the meat. Optimizing other on-farm factors, and pre and post slaughter handling for this group of lambs/carcasses will potentially have a greater impact on improving the pH and redness of lamb loins shipped for export in a chilled state, than discriminating against a class of carcass on sex grounds.

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