Influence of rearing and age at slaughter on carcass and meat quality of veal calves


SUMMARY

Veal calves were reared post-weaning using two methods: inside on milk and outside on grass (both with access to pellets). Calves were serial slaughtered at 10, 12, 14, 16 and 18 weeks of age. Carcass and meat quality characteristics were measured. Calves reared outside on pasture produced carcasses which were lighter in weight, leaner and had a lower conformation score. In addition, the meat was darker, redder and had a higher pigment content than the meat from calves reared inside on milk. Meat tenderness was similar in both treatments. Calves slaughtered at an older age (14-18 weeks) generally produced heavier carcasses with meat which was redder and yellower in the M semimembranosus (SM) with variable lightness. Age at slaughter had no effect on the meat colour of the M longissimus dorsi (LD). Meat in the LD and in the SM tended to be less tender from older calves. There was no interaction of age with method of rearing in any parameter measured. (Keywords: veal, meat quality, age, nutrition).

INTRODUCTION

In the past, the marketing of red meats in Australia has been characterised by limited market development work. An exploratory assessment of the market for medium to heavy weight veal carcasses in Victoria concluded that an excellent product development opportunity existed for veal (P. Bailey, pers. comm.). Veal is generally perceived as a high-quality, tender, light-coloured meat which contains very little visible fat. European systems of producing veal rely on intensive housing and rearing.

Traditionally, most veal sold in Victoria is derived from bobby calves (1-3 weeks old). In contrast to intensively milk-fed calves, few meat quality data are available on pasture-reared veal calves. Pasture-rearing is a potentially cheaper system of calf production, thus this experiment aimed to investigate the effects of method of rearing and age at slaughter on the carcass and meat characteristics of veal calves.

MATERIALS AND METHODS

Forty Friesian bull calves of mixed origin but known age, bought in the local saleyard, were individually fed milk and reared in an enclosed shed on the Ellinbank Dairy Research Institute. At four weeks of age, calves were allocated at random to either of two rearing treatments:

1. Group-fed 10 L milk/head/day outside on pasture until eight weeks and then weaned onto improved pasture (ryegrass/clover) until slaughter.
2. Housed and group-fed 10 L milk/head/day through to slaughter.

Access to Barastoc Calf Grower Pellets (Reg. Trademark) (Fe content = 500 ppm) was provided throughout the trial to both groups. Four calves from
each treatment were slaughtered at 10, 12, 14, 16 and 18 weeks of age. Calves were randomly allocated to slaughter except for ensuring that the average live weight of the slaughter group was equivalent to the average live weight of the respective treatment group.

Calves were transported to the abattoir (about 10 km) and slaughtered within 2 h of arrival. Carcasses were electrically stimulated within 10 mins of exsanguination using low-voltage electrical stimulation equipment (AIS LVS-4 with nostril-rectal probes). After about 24 hr chilling, cold carcass weight was measured and the conformation score of the butt assessed (1 = concave, thin musculature; 5 = convex, thick musculature). Samples of the M. longissimus dorsi (LD) and the M. semimembranosus (SM) were removed for objective tenderness measurements as described by Currie et al. (1988). A 12-13th rib section was removed and the fat depth over the rib (45 mm from the midline) and ultimate pH (Jenco 6102 pH meter with temperature probe and automatic temperature compensation: Ionde L250 electrode) measured. Colour was measured objectively on the LD and SM 30 min after slicing, using a Minolta chroma meter (CR-100) which produces colour measurements in terms of lightness (L-value), redness/greeness (‘a’-value) and yellowness/blueness (‘b’-value). The LD was removed from the rib section and frozen for pigment analysis. Total pigment content was measured on a 5 g frozen minced sample, extracting with 0.04M phosphate buffer (pH 6.8) and using the method described by Wariss (1979).

A 2 (method of rearing) x 5 (slaughter age) analysis of variance was conducted assuming random allocation of calves to slaughter.

RESULTS

Mean live weight of calves for the two treatments was the same at 4 weeks (55.1 kg) and similar at 8 weeks (83.4 vs 83.9 kg). Pasture-reared calves had a similar consumption of pellets pre-weaning compared to shed-reared calves (0.3 vs. 0.2 kg/head/day, respectively) but post-weaning, their consumption was higher than for shed-reared calves (3 vs. 1 kg/head/day, respectively).

The means and standard error of the differences for rearing treatment and age with respect to all measurements are presented in Table 1. There was no interaction of age with method of rearing for any measurement.

Carcass characteristics

Cold carcass weight increased for each successive slaughter age from 14 to 18 weeks (P < 0.01). Carcass conformation score and fat depth did not differ significantly for calves slaughtered over successive weeks. Calves reared inside on milk had a higher cold carcass weight (P < 0.01), a higher conformation score (ie. thicker musculature) (P < 0.01) and a greater fat depth (P < 0.01). When cold carcass weight was included as a covariate in the anlayses (results not presented), the effect of rearing treatment on fat depth was removed.

Meat characteristics

All carcasses exhibited meat in the normal ultimate pH (pHu) range (5.4–5.8). Although pHu was lower for calves slaughtered at 18 weeks (P < 0.05), the difference is not of practical significance because meat quality problems are generally not encountered unless pHu is above 5.8. In addition, instrument variability and intra-muscle variation can account for up to 0.2 pH units difference (R Warner, unpublished results).

Meat colour differences were evident between calves reared inside on milk.
and those reared outside on grass. The calves reared inside on milk produced meat which contained less pigment ($P < 0.01$) and thus was lighter (higher L-value) and less red (lower 'a' value). The pigment content and colour of the LD did not differ between calves killed over 10-18 weeks, however the SM exhibited variable lightness with age and was redder ($P < 0.05$) and yellower ($P < 0.05$) (higher 'b' value) for 18-week old calves compared to 10 to 14-week old calves.

Table 1 Effects of age at slaughter and method of rearing on carcass and meat characteristics of veal calves

<table>
<thead>
<tr>
<th>Slaughter age (weeks)</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>SED*</th>
<th>Milk</th>
<th>Grass</th>
<th>SED*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conformation score</td>
<td>1.8</td>
<td>2.0</td>
<td>1.9</td>
<td>1.6</td>
<td>1.6</td>
<td>0.2</td>
<td>2.0</td>
<td>1.6</td>
<td>0.1**</td>
</tr>
<tr>
<td>Fat depth (mm)</td>
<td>0.6</td>
<td>0.9</td>
<td>1.1</td>
<td>0.9</td>
<td>0.8</td>
<td>0.2</td>
<td>1.1</td>
<td>0.6</td>
<td>0.1**</td>
</tr>
<tr>
<td>M. long. dorsi L</td>
<td>41.4</td>
<td>42.5</td>
<td>43.2</td>
<td>40.4</td>
<td>42.3</td>
<td>1.3</td>
<td>44.4</td>
<td>39.6</td>
<td>0.8**</td>
</tr>
<tr>
<td>a</td>
<td>9.0</td>
<td>9.0</td>
<td>8.0</td>
<td>9.1</td>
<td>9.5</td>
<td>0.7</td>
<td>8.1</td>
<td>9.7</td>
<td>0.4**</td>
</tr>
<tr>
<td>b</td>
<td>4.2</td>
<td>4.4</td>
<td>3.7</td>
<td>4.1</td>
<td>4.4</td>
<td>0.4</td>
<td>4.2</td>
<td>4.1</td>
<td>0.2</td>
</tr>
<tr>
<td>pHu</td>
<td>5.55</td>
<td>5.50</td>
<td>5.49</td>
<td>5.55</td>
<td>5.42</td>
<td>0.03*</td>
<td>5.49</td>
<td>5.51</td>
<td>0.02</td>
</tr>
<tr>
<td>Pigment conc. (mg/g)</td>
<td>0.23</td>
<td>0.18</td>
<td>0.19</td>
<td>0.20</td>
<td>0.23</td>
<td>0.02</td>
<td>0.18</td>
<td>0.23</td>
<td>0.01**</td>
</tr>
<tr>
<td>M. semimembr. L</td>
<td>41.7</td>
<td>42.1</td>
<td>46.9</td>
<td>42.3</td>
<td>45.3</td>
<td>1.4*</td>
<td>46.5</td>
<td>40.8</td>
<td>0.9**</td>
</tr>
<tr>
<td>a</td>
<td>10.2</td>
<td>9.6</td>
<td>9.7</td>
<td>10.8</td>
<td>11.9</td>
<td>0.7*</td>
<td>9.6</td>
<td>11.2</td>
<td>0.4**</td>
</tr>
<tr>
<td>b</td>
<td>5.5</td>
<td>5.2</td>
<td>6.2</td>
<td>6.0</td>
<td>7.8</td>
<td>0.7*</td>
<td>6.5</td>
<td>5.7</td>
<td>0.1</td>
</tr>
<tr>
<td>pHu</td>
<td>5.48</td>
<td>5.46</td>
<td>5.49</td>
<td>5.46</td>
<td>5.40</td>
<td>0.02*</td>
<td>5.46</td>
<td>5.45</td>
<td>0.02</td>
</tr>
<tr>
<td>Warner-Bratzler peak shear (kg)</td>
<td>3.41</td>
<td>3.58</td>
<td>4.09</td>
<td>4.55</td>
<td>4.10</td>
<td>0.40</td>
<td>4.18</td>
<td>3.72</td>
<td>0.25</td>
</tr>
<tr>
<td>M. long. dorsi</td>
<td>3.26</td>
<td>4.14</td>
<td>5.96</td>
<td>5.10</td>
<td>5.49</td>
<td>0.62*</td>
<td>5.04</td>
<td>4.53</td>
<td>0.39</td>
</tr>
<tr>
<td>M. semimembr.</td>
<td>3.26</td>
<td>4.14</td>
<td>5.96</td>
<td>5.10</td>
<td>5.49</td>
<td>0.62*</td>
<td>5.04</td>
<td>4.53</td>
<td>0.39</td>
</tr>
</tbody>
</table>

**Conformation score: 1 = concave, thin musculature; 5 = convex, thick musculature. **p < 0.05 **p < 0.01 These denote a significant effect of treatment.

*SED - Standard Error of Difference

The Warner-Bratzler (W-B) peak shear force tended to be lower for the LD and SM, in the pasture-reared calves. However, due to high levels of variation between animals (CV = 20.4%), this was not significant. Generally, the W-B peak shear force increased with age for the SM ($P < 0.05$) and the LD ($P < 0.08$), particularly beyond 10-12 weeks (see Table 1 for details).

**DISCUSSION**

Veal calves reared inside and fed milk, produced carcasses which were heavier and fatter with thicker musculature and paler meat than similar calves reared outside on pasture. Pale meat colour in veal is one of the criteria by which the consumer evaluates its quality (Charpentier 1970). In Victoria, meat from bobby calves (1-3 weeks old) has an L-value of 45-55 whereas the meat from lot-fed beef ranges from 30-40 (R. Warner, unpublished results). The meat of calves reared inside on milk had an average L-value of 45, whereas the meat of pasture-reared calves had an average L-value of 40 and might be considered too dark for veal. The colour of meat from veal calves is determined by muscle pigment content which is related to dietary iron concentration (McDougall et al. 1973) and to the inclusion of roughage in feed (Smulders and Visser 1987). The diet of calves on
pasture would contain relatively high levels of roughage and iron from grass and soil, compared to the diet of calves on milk. The meat colour of calves slaughtered from 10 to 18 weeks was variable depending on the muscle studied. The pigment content and colour of the LD was unaffected by age at slaughter. Romita et al. (1978) also found no difference in meat reflectance for calves slaughtered at 20 and 28 weeks of age, however, by 36 weeks of age, meat reflectance had declined. The general increase in redness and yellowness of the SM was not unusual although the variation in lightness of the SM was probably a result of the increased susceptibility of this muscle to PSE (pale, soft, exudative) – type meat under certain conditions.

Conformation score or muscle thickness is important to the meat industry as it is assumed to indicate yield from the carcass. Premium prices in Victoria have been offered (Anderson, pers. comm.) for veal carcasses with a conformation score above 2.5. The veal market also requires a low-fat carcass with a premium being paid for carcasses with a fat depth of 0-1 mm (Anderson, pers. comm.). The fat depths of carcasses produced in this trial were sufficiently low to obtain premiums, but most carcasses would have been penalised for conformation score. This is probably a consequence of breed-type used: dairy breeds are known to have a more angular conformation than traditional beef breeds.

Grass-fed calves produced meat of similar tenderness to milk-fed calves. Meat with a W-B initial yield above 8 kg (Powell et al. 1986) is considered tough if eaten. For veal calves up to 18 weeks old, the W-B initial yield is about 5% less than peak force (Bouton et al. 1978) and thus our peak force values (only up to 6 kg) indicate that the meat from this trial would be considered acceptable. Meat tenderness declines with age over 1-4 years (Bouton et al. 1978). Younger calves produced more tender meat over the narrow age range considered in this trial.

In conclusion, method of rearing had a greater effect on veal carcasses and meat quality than slaughter age between 10 and 18 weeks. Veal calves reared outside on pasture post-weaning grew more slowly and produced a carcass which was less acceptable to industry in terms of meat colour and conformation (muscle thickness). However, tenderness and leanness were optimised. Age at slaughter (10 to 18 weeks) had a minimal effect on meat colour. Tenderness tended to decrease and carcass weight increase, with increasing age.

ACKNOWLEDGMENTS

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REFERENCES