Increased eye temperature of cattle is associated with reduced glycogen in the *M. longissimus thoracis et lumborum* following slaughter.

F. Anderson[AC], P. McGilchrist[B], S. Pitcher[A], D.W. Miller[A]

[A]Murdoch University, College of Science, Health, Engineering and Education, 90 South St Murdoch, WA, 6150
[B]School of Environmental and Rural Science, University of New England, Armidale, NSW 2350
[C]Email:F.Anderson@murdoch.edu.au

Low concentration of muscle glycogen at the time of slaughter can result in a high ultimate carcass pH (pHu) due to reduced substrate availability for post mortem glycolysis. This can cause reduced meat quality though the development of 'dark cutting' (Tarrant 1981), which has an estimated cost to the Australian beef industry of up to $55 million per annum (Jose, McGilchrist, Perovic et al. 2015). Pre-slaughter stress is thought to reduce muscle glycogen and result in dark cutting, but a convenient 'crush-side' test for animals under stress, and hence prone to dark cutting, remains elusive. There is some evidence that thermal imaging can reveal changes in body temperature related to stress and meat quality (McManus, Tanure, Peripolli et al. 2016), and in particular the eyes which have rich capillary beds innervated by the sympathetic system (Pavlidis, Eberhardt and Levine 2002). Therefore, we hypothesised that eye temperature of cattle would be associated with muscle glycogen concentrations.

Data was collected from a total of 240 cattle that originated from a single property. Cattle were inducted in to a feedlot and managed as 4 separate groups within a Western Australian feedlot for 100 days prior to slaughter. Ocular (eye) thermography was undertaken using a FLIR E4 digital camera (FLIR Systems, In., Wilsonville, OR) at the time of induction to the feedlot, day 70 and in the pre-slaughter period. Muscle samples were collected from the *M. longissimus lumborum et lumborum* immediately post-slaughter and analysed for glycogen. Data were analysed using linear mixed effects models in SAS (SAS Version 9.1, SAS Institute, Cary, NC, USA) with post-slaughter glycogen the dependent variable, sex included as a fixed effect and group included as a random term.

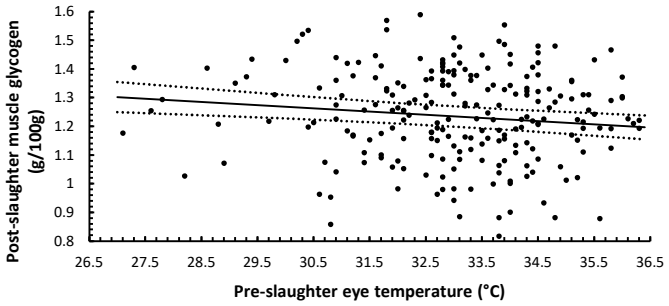

Figure 1. The relationship between cattle post slaughter muscle glycogen (g/100g) and pre slaughter mean eye temperature (°C). Line represents least square means (± s.e as dashed lines) and dots represent deviations from the predicted means for muscle glycogen (g/100g).

There was a negative relationship of post slaughter glycogen in the *M. longissimus lumborum et lumborum* and the mean eye temperature at induction to the feedlot ($P<0.05$) and in the pre-slaughter period ($P<0.1$). Across a 9.1 °C increase in pre-slaughter mean eye temperature, there was a decrease in muscle glycogen of 0.11 g/100g, or 8 % (Figure 1). There was no association of eye temperature with acute measures of stress (cortisol, lactate and glucose) taken at the same time period ($P>0.1$).

In support of our hypothesis, eye temperature at feedlot induction and preslaughter was associated with post slaughter muscle glycogen. It is perhaps unsurprising that there was minimal predictive power of the data collected, given the pHu was less than 5.7 and only 4.6% of cattle had muscle glycogen below the lower limit considered adequate to minimise the risk of dark cutting (0.8-1%). The relationship between glycogen and eye temperature has not been previously demonstrated, although other studies have demonstrated a relationship between eye temperature meat colour and pHu (Cuthbertson, Tarr, Loudon et al. 2020). The biological mechanism that links eye temperature with post slaughter muscle glycogen is unclear, with ocular thermography not related to acute measures of stress at slaughter in this study (plasma cortisol, lactate and glucose). However, it has been suggested that the increased temperature of the eye reflects a cognitive awareness of stress that can differ to the physiological response (Stewart, Webster, Verkerk et al. 2007). This experiment demonstrates ocular thermography measured at induction to the feedlot and preslaughter may be a useful non-invasive predictor of post-slaughter muscle glycogen and therefore potentially be a predictor of dark cutting in cattle.

Resources

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