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The use of flight speed as predictor of pre-slaughter stress and consumer eating quality in pasture finished beef cattle (#452)

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Introduction

Pre-slaughter acute stress and adrenergic depletion of muscle glycogen resulting in a high ultimate pH (>5.7) 'dark cutting' carcass, has a detrimental impact on beef meat quality (Tarrant, 1989; Ferguson et al., 2001). Meat Standards Australia (MSA) developed pre-slaughter eligibility protocols which penalises stressful pathways however the penalty is placed on the group as a whole which ignores an individual's difference in their response to stress. There is currently no commercial pre-slaughter biomarker to identify which individuals are at highest risk of resulting in poor beef quality. The industry ideal would be to identify at risk animals prior to slaughter, via a non-invasive tool, to enable remediation to the affected animal thus improving meat quality. Cattle with excitable temperaments are known to have increased adrenergic and contraction linked glycogenolysis when stressed (Grandin, 1993). Flight speed (FS) has been demonstrated to be an accurate instrument to measure temperament and excitability (Vetters et al., 2013). It is hypothesised that animals with increased FS will have decreased muscle glycogen and increased acute stress plasma metabolites (glucose, L-lactate) and muscle damage enzymes (creatinine kinase (CK), aspartate transaminase (AST)) at slaughter.

Methods

Pasture raised British breed beef cattle (n=488) from eight commercial properties in two geographical locations in Tasmania (King Island (KI) and north-western mainland (TAS)) supplied an even split of heifer and steer slaughter cattle. Three weeks prior to slaughter cattle were weighed and FS recorded via dual laser beams with infra-red receptors as the animal was released from the crush. The first sensor was positioned 1metre from the crush exit. The distance between the two sensors ranged from 1,760 to 6,250cm due individual yard layout. FS was calculated as time required to travel divided by distance in metres per second (m/s). All cattle were slaughtered at the same processing plant. Transport of experimental cattle was via typical commercial pathways, sea transport for KI and via saleyards for TAS. On arrival at the abattoir cattle were divided into two slaughter groups, direct slaughter or rested in pasture holding paddocks next to lairage for 14days rest prior to slaughter.

Blood was collected during exsanguination and analysed for stress metabolites glucose, L-lactate, CK & AST using methodology described in Stewart *et al* (2018). A core sample of *m. lonissiumus thoracis* was taken approximately 40minutes after death for muscle glycogen concentration by the methodology described in Gardner *et al* (Gardner et al., 2001). The day following slaughter carcasses were graded to MSA requirements using the methodology described in Loudon *et al* (2018).

Statistical analyses were performed in R (R Core Team, 2018). CK and AST exhibited skewness so natural logarithms were applied and analyses undertaken using transformed data. Correlation analysis was performed using Pearson correlation coefficients. FS, muscle and plasma metabolites were analysed using linear mixed effects models via lme4 R package (Bates et al., 2014) with transport type and kill group as fixed effects and property of origin as a random term.

Results

Expected paired correlations existed, glucose and lactate were strongly correlated, as were AST and CK. The metabolite with the strongest correlation to muscle glycogen was CK ($P<0.001$, $r= -0.52$, $r2 = 0.27$). The correlation between FS and CK was 0.17 with an associated r2 value of 0.03.

On multivariate analysis FS was significantly associated with lactate and glucose in both locations ($P<0.01$). Higher means were seen KI, a one meter per second increase in FS raised lactate by 0.90 ± 0.26mmol/L and glucose by 0.34 ± 0.10mmol/L, whilst in TAS lactate was increased by 0.47 ± 0.19mmol/L and glucose by 0.24 ± 0.07mmol/L. Muscle damage enzyme indicators were significantly associated with FS ($P<0.01$). A 1meter per second increase in FS raised plasma CK by 14 ± 5% and AST by 6% ± 3% in KI however in TAS only CK was significant, an 8 ± 4% increase with a 1meter per second faster flight time.

Conclusion

Contrary to our hypothesis, there was no association between FS and muscle glycogen. This result supports that of Coombes *et al* (2014) where FS was associated with increased muscle and plasma lactate but not with muscle glycogen. The CK and FS association suggests cattle with flightier temper

Notes

aments have increased muscle exertion in the pre-slaughter period. Whilst it is not clear as to why there was no association with muscle glycogen, CK may be influencing beef eating quality irrespective of muscle glycogen and ultimate pH. Café *et al* (2011) demonstrated increased FS was associated with slower pH decline and increased shear force on objective meat quality analysis and Loudon *et al* (2019, unpublished) demonstrated increased CK reduced consumer eating quality scores independent of ultimate pH. Further investigation is required to tease apart the influence of CK on meat quality to determine if FS would be a useful non-invasive tool in detecting at risk animals.

Notes