Bushfire exposure associated with increased beef loin pH at grading

Melindee Hastie [1], Graham Hepworth [1], Allison Hillman [2], Brendan Cowled [2], Caitlin Pfiefer [1], Robyn Warner [1]

[1] The University of Melbourne, [2] AUSVET, Australia

Objectives: In the spring to autumn period of 2019/2020, more than 100 000 square kilometres of Australian land was burnt by fires. The effect of these fires on the Australian livestock industry extended beyond the loss of animals and farming assets. Anecdotal re- ports from beef processors suggest there was a higher incidence of the carcase quality defect "high pH" (pH>5.70) observed. This has financial implications for beef producers as "high pH" carcases can be downgraded to manufacturing meat, and become ineligible for Meat Standards Australia (MSA) grading. To understand the association between fire exposure and loin pH, an investigation focussing on MSA data for fire affected beef cattle was conducted. The objective was to develop predictive models to estimate the association between fire exposure and (1) pH at grading, and (2) the incidence of "high pH" defects.

Materials and Methods: Temporal and geospatial fire data covering two bushfire seasons (2018-2019, 2019-2020) was collated with the locations of beef producing properties (farms and feedlots). Animals from these properties were identified as fire-affected if there had been a fire within 50 km of their originating property in the 180 days preceding processing of the animal (n= 451 299). Animal production, processing and carcase data was then collated. Two outcomes were considered (1) loin pH at grading and (2) the occurrence of high pH defects. For model (1), mixed linear modelling was used; the final model's fixed terms included the variables "time since closest fire", "distance of property from closest fire", "log days of fire", "feed type (grain or grass) ", "use of hormone growth promotants (HGP)", "sex (male or female)", "ossification score", "hump height (an indicator of *bos indicus* content)", the interactions of "distance of property from closest fire and feed type", and "log days of fire and HGP". For model (2), generalised linear modelling was used with a logit link function fitted on the binary outcome of normal (0; pH ≤ 5.70) vs high pH (1; pH>5.70). The final model for high pH was similar to that for loin pH excepting that 'sex' excluded.

Results and Discussion: Decreasing "time since fire exposure" and decreasing "distance of property from fire" were associated with increasing loin pH, and the incidence of high pH carcases, ($P < 0.05$ for all). In both models there were also significant interactions for "distance of the property from fire" with feed type (grain vs grass) and "days of fire exposure" with HGP treatment (no vs yes), such that the incidence of high pH and dark colour defects were exacerbated in grass-fed cattle (relative to grain-fed) and this dif- ference reduced with increasing "distance of the property from the closest fire". Cattle treated with hormonal growth promotants (HGPs) also had increased high pH defects relative to no HGP treatment, but the HGP treatment effects increased as "days of fire exposure" increased. Bushfire exposure induces animal stress through injury, fear, periods of flight, excessive environmental heat, displacement and mixing with unfamiliar animals. pH at grading is affected by pre-slaughter stress and physical exertion as both induce rapid pre-mortem muscle glycogen depletion. If muscle glycogen levels are low at the time of slaughter (< 60 umol/g), post- mortem anaerobic metabolism ceases earlier, lactic acid production is reduced and muscles will not reach "normal" ultimate pH (5.6). Once the muscle glycogen levels in a ruminant are depleted, recovery can take a week or more if the stressor has been re- moved, and access to adequate nutrition, and water is provided, but recovery times may be extended if the animal cannot be kept under optimal conditions, which is likely after bushfire exposure. In terms of susceptibility to fire induced stress effects, Grain fed "HGP-no" cattle were the most resilient, and for a fire exposure at 10 km distance, with 5 days of fire exposure, the predicted rate of high pH defects was 0.8%, increasing to just 1.1% for 150 days of continuous fire. The next most resilient, was grass fed "HGP- no", which at 10 km distance with 5 days of fire exposure had a failure rate of 1.8% for high pH increasing to 2.5% with 150 days of fire exposure. The use of HGPs was associated with substantially increased failure rates for pH for both feed types, with grain fed "HGP-yes" animals 10 km distance with 5 days fire exposure having a high pH failure rate of 3.7%, which increased to 5.0% for 150 days of fire exposure, and for grass fed "HGP-yes" animals under the same conditions the rate increased from 7.7% to 10.3%.

The finding that HGP usage substantially increases animal susceptibility to fire exposure in terms of increased rates of high pH meat was unexpected. This study's findings will inform the development of guidelines for the future management of fire affected livestock. The authors gratefully acknowledge support from Meat-and-Livestock-Australia

Key words: pH, Beef, Bushfire, Hormone proth promotants, Meat Standards Australia