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ORIGINAL PAPER

Effect of heat stress on meat quality: A mini review

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Environmental temperature has been known to influence the production performances of farm animals. In the present changing climate scenario, heat stress can impact meat quality as well as meat safety. Heat stress during the summer months severely hampers the pasture and water availability which ultimately culminates in imposing severe nutritional and water stress to the animals. Also there are direct effects on organ and muscle metabolism during heat exposure which can persist after slaughter. Heat contributes to live weight loss and mortality during transport to the abattoir. In addition to this global warming could affect microbial burdens on carcasses and meat, especially if the animals carry more enteric pathogens in their gut or on their body surface.

CATTLE

Heat stress results in dark cutting beef in cattle and dehydration in most species. Marenčić et al. (2012) reported that heifer beef had poorer pH, electric conductivity and colour values in the summer period compared to other seasons. Similarly distinctly higher values of L* were found in the winter season in all cattle categories excluding meat from cows in which L* in summer was slightly higher than in winter (Węglarz, 2010). Ruby et al (2007) also reported that the proportion of Salmonella positive beef carcasses was high during summer.

SHEEP AND GOAT

In sheep under high ambient temperatures, compensatory physiological mechanisms are triggered, causing drastic changes in the biological functioning of the animals. These changes in biological functions can result in a decrease of body weight and growth rate (Marai et al., 2000). According to Gregory (2010) extreme heat provokes adrenaline response which stimulates peripheral vasodilatation and muscle

glycogenolysis severely affecting meat quality (Lowe et al. 2002). If exposure is protracted before slaughter it could lead to high pH and darker meat. High temperatures could lead to dehydration in water deprived animals and can affect meat quality by making it darker in colour through shrinkage of the myofibril (Jacob et al., 2006). Summer affected the lightness, yellowness and tenderness of meat with increased plasma creatine kinase activity in sheep (Chulayo and Muchenje 2013). Also there is a risk that the meat could be tougher through a heat-shortening effect, in heat stressed animals though the reasons underpinning this seasonal effect were not established. Liu et al (2012) reported no differences in final BW, ADG, or rectal temperature in grazing sheep. However, pH24 and cooking loss were greater and lightness (L*), redness (a*) and yellowness (b*) values were lower ($P < 0.05$) in unshaded versus shaded sheep.

PIG

Among the livestock pigs are very sensitive to hot conditions. This is mainly due to the low sweating capacity (Nardone, et al., 2010). For example heat stress can increase the risks of pale-soft-exudative meat in pigs and turkeys (McKee & Sams, 1997). Seasonal changes have been reported to have a negative effect on the quality of pork (Rodríguez-Sánchez et al., 2009). Prolonged heat stress has been reported to reduce the rate of protein deposition in growing and finishing pigs (Kerr et al., 2003; Le Bellego et al., 2002). Lehotayová et al. (2012) reported that high temperature significantly lowered muscle $pH_{24hours,}$ however, had no significant effect on shear force, drip loss and meat colour in pigs. Drip loss was significantly greater in summer than in winter from longissimus dorsi muscle of pigs (Brown et al., 2012). Moro et al. (2000) reported that heat stress before slaughter increased the numbers of ampicillin and tetracycline resistant *Escherichia coli* in the faeces and on the surface of the pig carcass. According to Gregory (1998) the meat from heat stressed pigs and turkeys may be paler in colour with more drip forming when presented as cuts.

POULTRY

Several studies have shown the deleterious effect of heat stress on meat characteristics in broilers (Zhang et al., 2012) including meat quality losses due to the transportation under high environmental temperature from farms to processing facilities (Dadgar et al., 2010). During the summer months, high antemortem temperatures can affect muscle acidification, or rigor development and subsequent meat quality. Om-Alsala meet al (2013) reported that broiler breast meat obtained from chickens reared and processed under warm temperature (summer) undergoes a significant deterioration in water holding capacity properties in respect with birds kept at cool temperature (winter). Skin tears and muscle damage during plucking were more common during warmer months, especially in kosher slaughtered broilers. The effect may be due to weaker skin in birds grown during the warmer season (Pitcovskiet al., 1994). Chronic heat stress has a negative impact the growth performance, meat quality, and the postmortem muscle structure of broilers (Liu et al., 2022).

CONCLUSION

There have been concerns, that rising environmental temperatures will pose a greater risk to meat quality and meat safety in a range of species. These hazards can be best managed by pre-emptive strategies such as changing the genotype, feeding low protein-high fat finisher rations to combat heat induced growth suppression, pre-conditioning of animals to hot conditions to improve survivability during transportation, introducing better methods of cooling the animals, presenting animals for slaughter in a clean condition, maintaining hygienic standards in carcass dressing and adequate product refrigeration.

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