EFFECT OF PRESLAUGHTER HEAT STRESS, EXERCISE OR ADRENALINE INJECTION ON POSTMORTEM HEAT-STAB PINKNESS, TEXTURE AND WATER HOLDING CAPACITY IN CHICKEN

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Background

Many broiler chickens experience heat stress and exercise (wing flapping) shortly before they are slaughtered. Previous research has showr extreme situations, both heat stress and exercise can influence muscle metabolism and meat quality (Ngoka and Froning, 1982; Lee *et al.*, 19 However, we do not know whether these stressors are an important cause of variation in meat quality under commercial conditions, a practice the stressors may not be as severe as those used in research studies. One of the meat quality defects in broilers that is becoming n common is heat stable pinkness. Heat stable pinkness is characterised by meat failing to turn brown when it is cooked, which creates a f impression that it is undercooked. This defect commonly occurs during summertime, and it is often attributed to nitrate contamination of water supply to the processing plant (Maga, 1994). Nitrate leads to nitrosomyoglobin formation and pinkness in the cooked meat and ca assessed from a two to three-fold higher 'a' value in cooked thigh meat. However, a number of processing plants have eliminated high nitra the spin chiller water as the primary cause of their particular problem, and thus some other unknown factors must contribute to heat st pinkness. A recent study examined the role of preslaughter lipopolysaccharide-induced NO_x release on the formation of heat stable pinknes meat, but there was no obvious effect (Gregory *et al.,* unpublished results). Alternatively, heat stable pinkness could be due to failur myoglobin denaturation during cooking if the pH of the meat is unusually high (Trout, 1989). The study reported here set out to exa whether heat stable pinkness is linked to preslaughter exercise or heat stress induced through the formation of a high pH_{ult} meat. The study provided an opportunity to examine the effect of these stressors on other aspects of meat quality.

Objectives

Determine the effects of preslaughter heat, exercise, exercise plus heat, and adrenaline injection on meat quality in broiler chickens.

Methods

Male Cobb broilers with liveweights ranging 2.6-2.7 kg were divided into five treatment groups with 20 birds per group. The birds were without feed or water for 2-6 hours in the preslaughter period. The treatments were:

- No stress control.
- Exercise: exercised to exhaustion over a 5 minute period immediately before slaughter
- Heat stress: kept in a heated room for approximately 2 hours before slaughter
- Heat stress plus exercise: kept in a heated room for approximately 2.5 hours, and then exercised to exhaustion in a cool environment ov minute period immediately before slaughter
- Adrenaline injection: injected subcutaneously with 1.5 mg kg^{-1} 6 hours before slaughter.

Exercise was induced by handling the birds in a manner that caused them to flap their wings to exhaustion, and the temperature of the h room was maintained between 30 and 35°C. A sample of blood was taken from the wing vein for plasma catecholamine estimation immedi before slaughter by neck dislocation and severance of the neck. Abdominal temperature was recorded as the bird was bleeding out. Mea expressible juice area, and cooked meat colour (Minolta Chroma meter) and texture (MIRINZ tenderometer) were evaluated on days 2 using thighs and breast meat. The meat was cooked in a bag to either 75 or 80°C using a waterbath oven.

Results and Discussion

The birds held in the heated room were severely heat stressed, as judged by their abdominal temperatures, but those that were taken out of room for an exercise period managed to cool down a little before they were slaughtered. The exercise stress was not sufficient to cause a ris body temperature, but it had a marked effect on plasma noradrenaline and adrenaline. In spite of these pronounced changes in temperature catecholamines, only the birds in the adrenaline injection treatment had a raised pH_{ult}.

Adrenaline injection also resulted in meat which was more tender, had a lower expressible juice area, less weight loss on cooking and slig less drip in comparison with most of the other treatments. The heat stressed birds had normal catecholamine concentrations at slaughter an tougher breast meat at 24 hours after slaughter in comparison with the controls. By 48 hours after slaughter the meat of the heat stressed b had become more tender, but not as tender as the control birds. Following 7 days of storage, the thigh meat of the heat stressed birds, had lo more fluid than all the other groups. The brief episode of exercise stress before slaughter had little effect on meat quality in either the breas leg meat, even though these birds had elevated plasma catecholamine concentrations just before slaughter.

There were few effects on meat colour. Adrenaline injection and heat plus exercise made the meat slightly darker.

Linear regression analysis showed that pH_{ult} was negatively related to expressible juice area for the breast meat (r=-0.71, p<0.001), and th pH_{ult} was negatively related to % cooking loss in the thigh (r=-0.65, p<0.001). Plasma adrenaline was negatively correlated to thigh drip at days following slaughter (r= - 0.45, p<0.001).

Conclusions

This study has produced two important findings on heat stable pinkness in chicken meat. Firstly, high pH meat induced with a preslaugh injection of a large dose of adrenaline was not associated with heat stable pinkness. Previous work had shown that myoglobin is less prone temperature induced denaturation when the meat has a high pH (Trout 1989), but this study failed to demonstrate that this could be respons for heat stable pinkness as characterised by a high 'a' value, in cooked thigh meat. Secondly, a severe acute heat stress before slaughter did affect the 'a' value in thigh meat. It is thus unlikely that the high prevalence of heat stable pinkness during the summer is directly related to heat stress in the birds.

For the adrenaline treatment, a high (non-physiological) dose of adrenaline was used. As expected, the adrenaline injection 6 hours before slaughter resulted in high pH, tender, water-retentive meat. Exercise proved more effective than heat stress at provoking a rise in circulating adrenaline concentration.

The heat stress used in this study was a severe stress, close to the upper lethal temperature for broilers. The exercise stress was less severe in terms of survival but it provoked large increases in plasma catecholamines. In humans, heat stress is a predominantly adrenergic stressor as distinct from a noradrenergic stressor (Taggart *et al.*, 1972). Whereas, exercise is a mixed adrenergic plus noradrenergic stressor, and in this study it caused larger increases in plasma noradrenaline than adrenaline. It is recognised that noradrenaline is less effective at stimulating muscle glycogenolysis than adrenaline. In spite of the magnitude of the heat and the exercise stressors used in this study, they had no effect on meat pH, water holding capacity or colour. Heat stress caused slight toughening of the breast meat in comparison with some of the other treatments, which we suggest is due to a heat shortening effect, which partially resolved by 2 days post slaughter. Taken together, this suggests that preslaughter stress may have very little impact on these features of meat quality in broiler chickens.

References

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Table 1 Effect of preslaughter treatment on meat quality in broiler chickens

	Control	Exercise	Heat	Heat + exercise	Adrenaline
Body temperature °C	41.4 ± 0.2 [a]	41.4 ± 0.1 [a]	45.1 ± 0.2 [b]	43.7 ± 0.2 [c]	41.5 ± 0.1 [a]
Breast meat pH_{ult}	5.69 ± 0.02 [a]	5.72 ± 0.02 [a]	5.66 ± 0.02 [a]	5.69 ± 0.02 [a]	6.45 ± 0.06 [b]
Thigh L value (75°C)	63.74 ± 0.67 [a]	61.96 ± 0.65 [ab]	61.66 ± 0.52 [ab]	61.74 ± 0.69 [ab]	60.74 ± 0.57 [b]
Thigh L value (80°C)	63.20 ± 0.40 [a]	61.17 ± 0.46 [ab]	61.26 ± 0.72 [ab]	60.79 ± 0.57 [b]	60.57 ± 0.76 [b]
Thigh a value (75°C)	15.51 ± 0.30	16.30 ± 0.40	16.03 ± 0.35	16.01 ± 0.44	16.10 ± 0.35
Thigh a value (80°C)	11.34 ± 0.37	11.94 ± 0.35	11.54 ± 0.55	11.92 ± 0.35	12.05 ± 0.49
Breast expressible juice area	1147 ± 44 [a]	1179 ± 49 [a]	1221 ± 61 [a]	1194 ± 64 [a]	669 ± 36 [b]
Thigh drip 2 days (%)	0.64 ± 0.05	0.50 ± 0.03	0.59 ± 0.08	0.45 ± 0.06	0.49 ± 0.11
Thigh drip 7 days (%)	1.13 ± 0.14 [a]	0.96 ± 0.08 [ab]	1.24 ± 0.14 [a]	0.87 ± 0.10 [ab]	0.54 ± 0.05 [b]
Thigh cook loss (75°C)	12.0 ± 0.6 [a]	11.6 ± 0.5 [a]	13.0 ± 0.5 [a]	11.3 ± 0.5 [a]	7.0 ± 0.4 [b]
Thigh cook loss (80°C)	15.4 ± 0.8 [a]	14.3 ± 0.6 [a]	14.3 ± 0.4 [a]	13.7 ± 0.5 [a]	7.8 ± 0.4 [b]
Breast shear force (kg) 24 h	2.26 ± 0.09 [ab]	2.16 ± 0.08 [ab]	3.00 ± 0.21 [b]	2.51 ± 0.12 [b]	1.89 ± 0.12 [a]
Breast shear force (kg) 48 h	1.43 ± 0.09 [a]	1.42 ± 0.08 [a]	2.28 ± 0.15 [b]	1.92 ± 0.14 [ab]	1.66 ± 0.23 [a]
p. adrenaline (ng ml^{-1})	1.4 ± 0.3 [c]	5.1 ± 0.6 [bc]	2.3 ± 0.2 [bc]	5.4 ± 0.6 [ab]	8.8 ± 1.9 [a]
p. noradrenaline (ng ml^{-1})	4.0 ± 0.5 [b]	19.5 ± 2.2 [a]	4.4 ± 0.8 [b]	21.6 ± 3.4 [a]	2.7 ± 0.3 [b]