

Effects of crating on blood stress indicators, nutrient composition and meat quality traits of broilers reared at two rearing temperatures

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Introduction

From a welfare point of view, optimum temperature for chickens is 22-24°C between 4 and 7 wks. Temperature higher than 28°C has been recognized as having detrimental effect on broiler performance. Rearing temperature also influences on meat quality. Seasonal heat stress accelerated postmortem metabolism and biochemical changes in muscle in turkeys (McKee and Sams, 1997). Not only chronic high temperatures but also acute heat stress appeared the most detrimental preslaughter condition (Debut et al., 2003). Previous studies have showed that short-term acute heat stress prior to slaughter induced disturbances in blood acid/base status, had a detrimental effect on muscle membrane integrity, and lowered muscle pH (Lee et al., 1976; Sandercook et al., 2001). High ambient temperatures also reduce protein synthesis and deposition of breast meat in chickens (Temim et al., 2000). Crating as a preslaughter treatment is expected to have a negative impact on animal welfare. Yalçın et al. (2004) reported that as birds aged crating become more stressful compare to catching and transportation. Kannan and Mench (1996) reported that duration of crating could influence the stress response of broilers but it had no effect on meat quality of breast meat (Kannan et al., 1997). This experiment was therefore conducted to define the effects of crating on broilers reared at control and high rearing temperatures, taking the stress parameters and meat quality characteristics.

Materials and methods

A total of 320 commercial broiler chicks were randomly distributed into 8 floor pens (40 chicks/pen) and reared under standard brooding temperatures from 0 to 3 wks. At 3 wks, the chicks were divided into 2 rearing temperature groups: High temperature (Htemp): broilers exposed to constant 34°C from 3 to 7 wks while control broilers (Cont) were kept at 22°C. Relative humidity was 60% during the experiment. There were 4 replicate pens/temperature.

On d 49, a total of 12 broilers/ temperature were caught, blood was pulled from each broiler for glucose and blood ions analysis. One drop of blood was also taken from the same broilers to count heterophil (H) and lymphocyte (L) cells. Those birds were transported to slaughterhouse and slaughtered immediately. The 48 broilers (24 broilers/rearing temperature) were also sampled from the experiment and randomly placed into transport cages (dimensions 97x 57x 27 cm, 8 broilers/cage). Birds from Cont were held at 22°C while Htemp broilers were held at 34°C for 2 h in controlled chambers. Two hours later blood was collected again and birds were transported to slaughterhouse.

Breast meat samples were analyzed for glycogen, protein and lipid content. At 24 h postmortem, breast meat quality was assessed by measuring pH₂₄ and color. Color profile of L*(lightness), a* (redness), and b* (yellowness) was measured by colorimeter (Minolta Chroma Meter). To calculate hue angle, a* and b* coordinates were used ($H^* = \tan^{-1} b^*/a^*$). Data were analyzed by using the ANOVA option of the GLM procedure of SAS (SAS Institute, 1999). Main effects were rearing temperature and crating and interaction between those.

Results and Discussion

Before crating, there were no differences in blood glucose, Na⁺, K⁺, and Cl⁻ levels, and H and L counts of broilers from Cont and Htemp (Table 1). Several studies have shown that heat stress increases blood Na⁺ and Cl⁻ and decreases K⁺ levels (Etches et al., 1995). In the present study, the lack of such an effect, probably due to physiological adaptation of broilers to heat stress since broilers exposed to high temperature for 3 wk. Two h of crating of Cont broilers did not influence on blood parameters, except there was a decrease in blood glucose level. The H and L counts suggested that crating at 22°C for 2 h had no stressful effect on broilers. When Htemp broilers were crated for 2 h at 34°C, blood Na⁺ and Cl⁻ levels and H counts increased, L counts decreased compare with before crating. This led a significant interaction between rearing temperature and crating, and resulted higher blood glucose, Na⁺, and Cl⁻ levels, and H counts but lower L counts in broilers from Htemp and crated than those from Cont and crated. The increase in blood Na⁺ and Cl⁻ levels indicated a change in plasma osmolality. The higher levels of blood glucose and H counts could be explained by circulating higher glucocorticoid levels associated with stress in chickens (Puvadolpirod and Thaxton 2000). In contrast to our finding, a decrease in blood K⁺ level was reported when birds were exposed to high temperatures (Ait-Boulahsen et al., 1989). This increase in blood K⁺ may be an indicator of cell damage (Toyomizu et al., 2005).

Protein content reduced, lipid content increased in meat from Htemp compare with meat from Cont (Table 2). The decline in protein synthesis in heat stressed broilers is consistent with earlier studies (Temim et al., 2000; Yunianto et al., 1997). Crating had no effect on protein, lipid, and glycogen contents of breast muscle.

Exposure broilers to heat stress during rearing resulted lower pH₂₄. Muscle L* and a* values increased while H* values decreased in broilers from Htemp. These results are consistent with previous studies indicating pale meat is associated with lower pH₂₄ during summer (Barbut, 1998; Petracci et al., 2004). Crating had no effect on muscle pH₂₄ and L* and a* values, which was agree with Kannan et al. (1997). Neither rearing temperature nor crating influenced b*value.

In conclusion, these results showed that crating at 22°C had no effect on blood parameters measured in this study. Crating became a major stressor when broilers were crated at 34°C for 2 h. Neither crating nor crating temperature had detrimental effect on meat quality characteristics.

However, chronic heat stress had an effect on breast meat quality by reducing pH₂₄ and increasing L* and a* values of breast meat.

Table 1. Effects of crating¹ on blood parameters of broilers reared at control (22°C) and high temperatures (34°C)

Blood parameters	Crating	Temperature from 3 to 7 wks		
		Control	High	
Glucose	0 h	182 ^a	NS	197 ^a
	2 h	149 ^b	*	192 ^a
Na ⁺ , mM	0 h	133 ^a	NS	131 ^b
	2 h	136 ^a	*	147 ^a
K ⁺ , mM	0 h	3.8 ^a	NS	4.1 ^a
	2 h	3.4 ^a	*	4.1 ^a
Cl ⁻	0 h	94 ^a	NS	94 ^b
	2 h	96 ^a	*	104 ^a
Heterophil	0 h	27 ^a	NS	30 ^b
	2 h	26 ^a	*	43 ^a
Lymphocyte	0 h	72 ^a	NS	70 ^a

	2 h	75 ^a	*	57 ^b
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¹Broilers were crated at their rearing temperatures
^{a,b} Means within a column with no common superscripts differ significantly (P<0.05)
* Means within a row differ significantly (p<0.05), NS not significant

Table 2. Effects of crating¹ on breast meat composition and quality of broilers reared at control (22°C) and high temperatures (34°C)

Meat composition and quality	Crating	Temperature from 3 to 7 wks		
		Control		High
Protein	0 h	23.4 ^a	*	21.5 ^a
	2 h	23.2 ^a	*	21.9 ^a
Lipid	0 h	1.14 ^a	*	4.29 ^a
	2 h	1.09 ^a	*	4.67 ^a
Glycogen	0 h	0.19 ^a	*	0.10 ^a
	2 h	0.17 ^a	*	0.08 ^a
pH ₂₄	0 h	6.00 ^a	*	5.88 ^a
	2 h	5.99 ^a	*	5.87 ^a
L	0 h	48.89 ^a	*	53.99 ^a
	2 h	48.91 ^a	*	54.22 ^a
a*	0 h	3.10 ^a	*	5.17 ^a
	2 h	2.80 ^a	*	5.21 ^a
b*	0 h	4.15 ^a	NS	3.96 ^a
	2 h	4.01 ^a	NS	3.30 ^a
Hue	0 h	1.24 ^a	*	0.31 ^a
	2 h	1.23 ^a	*	0.15 ^a

¹Broilers were crated at their rearing temperatures
^{a,b} Means within a column with no common superscripts differ significantly (P<0.05)
* Means within a row differ significantly (p<0.05), NS not significant

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