Effect of dietary antioxidant on broiler meat quality under heat stress condition

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Abstract— **This study was conducted to evaluate the effect of dietary antioxidant on broiler meat quality, especially focused on PSE (pale color, soft and exudative), under chronic heat stress condition. 28 days old female Ross broilers were kept in independent cages with controlled temperature of 24 ºC (normal temperature: NT) or 30 ºC (heat stress: HS). The chickens of NT were fed basal feed that was adequate requirement of NRC (1994). The chickens of HS were fed basal feed (HS) or Vitamin E (200IU/kg) added feed (HS+E). Diets and water were provided *ad libitum*. Broilers were weighted and slaughtered at 38 days old. The pectoral muscle was removed immediately and stored at 4 ºC until determination of meat color, pH, water holding capacity (WHC) and share force value (SFV). Furthermore contents of free amino acids and peptides of meat were also measured. Body weight gain and feed intake was decreased in HS groups compared with NT. The pH values of meat were tend to decrease in only HS group on just after slaughtered. After 2 days of storing, SFV was significantly decreased in HS, but there was no difference between NT and HS+E. Content of free carnosine were decreased in HS and HS+E compared with NT. These results describe that dietary antioxidant ameliorate the degraded meat quality by heat stress.**

***Keywords*— heat stress, meat quality, antioxidant, feed**

I. INTRODUCTION

It is well known that high environment temperature can induce heat stress (HS) of animals and poultries. Yamazaki *et al.* (2008) reported that chronic HS by high environmental temperature of 30 ºC cause degradation of productivity. However the HS can't result in only degradation of the productivity but also the meat qualities like PSE (pale color, soft and exudative) on poultry meat (Sosnicki *et al.*, 1998). To develop the inhibition strategies of this degradation of meat quality by nutrients is very important. It is very limited, but some articles are reported the effect of dietary antioxidant typically vitamin E to prevent PSE (Olivo *et al.*, 2001, Zhang *et al.*, 2011). However it is not enough to understand about the effect on different HS condition such as chronic or acute stress. This study aimed to determine the effect of dietary antioxidant on meat quality parameters from chicken that reared with chronic heat stress condition.

Furthermore, carnosine (Car) and anserine (Ans), is described as imidazole dipeptides, has been known that functional components of chicken meat such as anti-oxidative and anti-fatigue action (Yanai *et al.*, 2008). Stress can effect on the level of amino acids and related compounds in various tissues (Decker *et al.*, 1995). Therefore, it was also investigated the effect of stress on contents of Car and Ans in this study.

II. MATERIALS AND METHODS

A. Animals

Ross strain broiler chicks were purchased from a commercial hatchery at 1 day old. All chicks were housed in a brooder kept warm from 1 to 14 days and fed commercial starter diet. From 14 days, they were housed in individual cages with controlled temperature at 24 degree C (normal temperature: NT) and lighting was controlled by a regular schedule (lighting 15h, 04:00 to 19:00). They were fed experimental feeds either basal feed or 200 mg/kg vitamin E (VE) supplemented feed. From 28 days, chicks fed basal feed was allocated to two groups, ensuring that average body weight was same across treatments (n=6 per group), and raised in either the temperature was 24 ºC (normal temperature: NT) or was 30 ºC (heat stress: HS). They were kept feeding of basal feed. Chicks fed VE supplemented feed was raised in the temperature

was 30 ºC and fed VE supplemented feed (HS+E). All chicks were allowed free access to feed and water.

B. Experimental diets

All nutrition levels were fulfilled the requirement of NRC (1994). Basal starter feed contained 23.0% of crude protein (CP), 3.20 kcal/g of metabolic energy (ME) and 14.9 IU/kg of VE were fed for chicks from 14 to 21 days old. Basal grower feed contained 20.0% of CP, 3.20 kcal/g of ME and 11.3IU/kg of VE were fed for chicks from 21 to 38 days old. Vitamin E 100 (Rokku Chemical Products. Co., Ltd., Tokyo, Japan), contained 100g dl-alpha-tocopherol /kg, was used for VE supplementation in both feeds.

C. Performance

Body weight and feed amounts were measured at 28 and 38days old (at the beginning and end of different temperature treatment). Body weight gain and feed intake was individually calculated for 10 days of different temperature treatment. At 38 days old, all chicks ware slaughtered by cutting the carotid arteries. After the slaughtering, breast muscle (*M. Pectralis superficialis*) and abdominal fat were taken and weighted immediately after the slaughtering.

D. Meat quality properties

Meat color and pH was measured at just after slaughtered (D 0) and 2 days stored in 4 ºC (D 2) samples of breast muscle. Water holding capacity (WHC), Shear force value (SFV) and content of free amino acids and peptides were measured at D 2 samples of breast muscle.

pH meter TPX-90i (Toko Chemical Laboratories Co., Ltd., Tokyo, Japan) was used to measure meat pH. Colorimeter CR-400 (Konica Minolta Sensing, Inc., Osaka, Japan) was used to evaluate the meat color (L*, a* and b*) on exterior surface of intact skinless breast muscle. L* (brightness), a* (redness) and b* (yellowness) values were obtained from 5 points measurement of each samples.

WHC of breast muscle stored for 2 days in 4 ºC was measured by centrifugation assay. The samples were cut into cube of 1 x 1 x 1 cm and then centrifuged at 1,000 x G (3,100rpm) at 4 ºC for 15 minutes. WHC was calculated from the difference in weight prior to and after centrifuging;

$$WHC\ (\%) = Wt2 / Wt1 \times 100$$

Wt1: Weight (g) of sample prior to centrifuging.

Wt2: Weight (g) of sample after centrifuging.

The muscle samples for SFV analysis were boiled by 70 ºC for 1 hour and then cut into 1 x 1 x 4 cm after cooling down to room temperature. These pieces were measured SFV by Rheo-mater (Fudoh Rheo Meter RT-2005J, Rheotech Ltd., Japan). The value was obtained from 12 measurements of each sample.

E. Preparation of muscle extracts

Muscle extracts were prepared as described by Imanari *et al*. (2007). The muscles were homogenized in perchloric acid with a high-speed homogenizer (Ultra-turrax T25 basic, Ikawerke, Staufen, Germany). The homogenate was then centrifuged and the supernatant was neutralized with 10% (w/v) potassium hydrate. After removal of potassium crystals by filtration, the filtrate volume was adjusted to 50 mL using double distilled water. The resulting samples were kept at -20°C until analysis.

F. Measurement of free amino acids and peptides content in muscles

The free amino acid levels in muscle were measured as described by Imanari *et al*. (2007) using an amino acid analyser (JLC-500/V; JEOL, Tokyo, Japan). The column used was a multi-segment tandem packed column (LC-500AC4016, Li type, 4 mm diameter x 160 mm; JEOL, Tokyo, Japan). The detection wavelengths were 440 and 570 nm. Amino acids were detected by the ninhydrin method.

G. Statistical methods

Means and standard errors were calculated for the chicks in both groups. For statistical analysis, one-way analysis of variance (ANOVA) was used with the GLM procedure in SAS (SAS Institute, 1985). Significant differences between means were determined by the LSD method.

III. RESULTS

Body weight gain and feed intake for 10 days of temperature controlled period were tended to decrease in HS and HS+E groups compared with NT. Breast muscle rate of HS and HS+E was also lower than NT.

The pH values of meat were tended to decrease in only HS group on D 0. But the pH values on D 2 samples were not different between groups. It was not significant but L* of HS was higher than NT and HS+E on both of D 0 and D 2. a* and b* values were not different between groups on both of D 0 and D 2. WHC was tended to decrease in HS compared with NT and HS+E. SFV was significantly decreased in HS, but there was no difference on the parameter between NT and HS+E.

Content of Car was decreased in HS and HS+E compared with NT. But content of Ans was not different between groups.

IV. DISCUSSIONS

The decreased growth performances by HS were almost similar with the decreased meat productivity reported by Yamazaki *et al.* (2008).

These results of meat quality properties suggested that chronic HS of 30°C for 10 days can cause degradation of meat quality like PSE. Furthermore it was become clear that the effects of HS on meat quality were most significant in the toughness on broiler meat and it could be ameliorated or prevented by dietary antioxidant.

Content of Car was decreased by HS and it was not affected by dietary vitamin E. Further studies will be necessary to unravel whether this decreasing Car was caused by physiological effect of stress or effect on aging process.

V. CONCLUSIONS

Chronic HS of 30°C for 10 days can cause degradation of meat quality like PSE. Furthermore it was become clear that the effects of HS on meat quality were most significant in the toughness on broiler meat and it could be ameliorated or prevented by dietary antioxidant.

REFERENCES

1. Decker R, Stuckrad-Barre S, Milakofsky L, *et al.* (1995) Effect of stress on amino acids and related compounds in various tissues of the rat. Life Sciences, 57 (19): 1781-1790.
2. Imanari M, Kadowaki M, Fujimura S. (2007) Regulation of taste-active components of meat by dietary leucine. British Poultry Science, 48 (2): 167-176
3. NRC (National Research Council). 1994. *Nutrient Requirements of Poultry*, 9th edn. National Academy Press, Washington, DC.
4. Olivo R, Soares A L, Ida E I *et al.* (2001) Dietary vitamin E inhibits poultry PSE and improves meat functional properties. Journal of Food Biochemistry, 25: 271-283.
5. SAS Institute. 1985. *SAS User's Guide, Version 5*. SAS Institute, Inc., Cary, NC.
6. Sosnicki A A, Greaser M L, Pieterzak M, *et al.* (1998) PSE-like syndrome in breast muscle of domestic turkeys: A review. Journal of Muscle Foods, 9: 13-23
7. Yamazaki M, Murakami H, Nakashima K *et al.* (2006) Impact of global warming on broiler meat production estimated from changes of the mean ambient temperature. Nihon Chikusan Gakkaiho, 77 (2): 231-235
8. Yanai N, Shiotani S, Hagiwara S, *et al.* (2008) Antioxidant combination inhibits reactive oxgen species mediated damage. Bioscience, Biotechnology, and Biochemistry, 72 (12): 3100-3106
9. Zhang W, Xiao S, Lee E J, *et al.* (2011) Consumption of oxidized oil increase oxidative stress in broilers and affects the quality of breast meat. Journal of Agricultural and Food Chemistry, 59: 969-974