ANTIOXIDANT ENZYMES ACTIVITY OF BREAST MEAT FROM TWO LINES OF KOREAN NATIVE CHICKEN COMPARED WITH WHITE LEGHORN

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Abstract – This study was conducted to observe the antioxidant enzymes activity, iron content and lipid oxidation of breast meat from different lines of Korean native chicken (KNC); *Yeonsan ogye* (YO) and *Hyunin* black (HB), compared with white leghorn (WL). Breast meat from YO was darker ($p<0.05$) than that of other chickens. There was no significant differences ($p>0.05$) among different lines of chicken on lipid oxidation, the activity of catalase (CAT) and iron content. Glutathione peroxidase (GSH-Px) and superoxide dismutase (SOD) activity were significantly higher ($p<0.05$) in breast meat from HB and YO, respectively. Therefore, we suggest that genotypes may affect the activity of antioxidant enzymes in breast meat.

Key Words – Glutathione peroxidase, lipid oxidation, poultry.

I. INTRODUCTION

Oxidation causes sensory quality deterioration in meat such as changes in color and promotes off-flavor. Furthermore, it generates compounds that give negative effect to human health [1]. Min and Ahn [2] mentioned that free ionic iron released from heme pigments and ferritin is considered as a catalyst in lipid oxidation. However, the amount of iron found in meat may vary among meat from different breeds and species.

Meat itself has self-defense mechanisms against oxidative processes. Catalase (CAT), glutathione peroxidase (GSH-Px) and superoxide dismutase (SOD) are endogenous antioxidant enzymes located in cytosol [3]. Study reported that the activity of those enzymes differ between meat from different part and species [4]. Hernández *et al.* [5] found that antioxidant enzymes activity vary between pork from different genotypes. However, the information on the factors affecting antioxidant enzymes activity in poultry meat, especially Korean native chickens is still limited. Thus, this study was aim to observe antioxidant enzymes activity, iron content and lipid oxidation in meat from two lines of Korean native chicken compared with white leghorn.

II. MATERIALS AND METHODS

Sample

Two Korean native chicken lines (*Yeonsan ogye* and *Hyunin* black) and white leghorn were raised with the same condition at Seoul National University farm (Suwon, Korea), slaughtered at the age of 7 months and the breast muscles (N = 15) were obtained.

Instrumental color and lipid oxidation

The surface colour was recorded by measuring CIE lightness (L*), redness (a*) and yellowness (b*) using a chromameter (CR-400, Konica Minolta Sensing Inc., Japan). TBARS were determined using a method as described by Sinhuber & Yu [6]. The results were calculated as mg malondialdehyde (MA) per kg meat.

Antioxidant enzymes activity

CAT activity was measured according to a modified version of a method described by Aebi [7]. The CAT activity was expressed as U/g sample. GSH-Px activity measurement was performed according to DeVore & Greene [8] with slight modification. The GSH-Px activity was expressed as U/g sample. SOD activity was measured using a modified version of a pyrogallol autoxidation method described by Marklund [9]. The SOD activity was expressed as U/g.

Iron content

The Heme-iron content was determined according to the Hornsey method of total pigment (hematin)

analysis with modification [10]. The iron content was calculated with a factor of 0.0882 µg iron/µg hematin [11]. The amount of free (non-heme) iron was measured based on a modified version of the ferrozine method, using citrate-phosphate buffer (pH 5.5) as extraction solvent [12, 13]. The free iron value was expressed as µg/g sample. The total iron was calculated by a summation of the heme iron and non-heme iron.

Statistical analysis

Data were subjected to one-way analysis of variance (ANOVA) using R-version 3.1.2 with "Agricolae" library (The R-foundation for Statistical Computing, Austria). The statistical significance of the differences between means from different treatments was determined by Duncan's multiple range test ($p \leq 0.05$).

III. RESULTS AND DISCUSSION

Meat quality attributes such as colour and oxidative stability are important to be evaluated. Genotypes, diets, pre-slaughter handling, slaughter method, and storage conditions are the main factors affecting these quality attributes [14]. Color, which is the first characteristic noticed by consumers, plays an important role as an indicator of meat quality. In this study, breast meat from different lines differed significantly ($p<0.05$), which is in line with the finding from Jaturasitha *et al*. [15] that chicken meat from different genotypes had different colour characteristics. Table 1 shows breast meat from WL was the reddest with the lowest hue angle as represented by the highest CIE a* and H^o values. Breast meat from HB had higher lightness, while that of YO had much darker colour than the others. YO or Korean silky fowl, originating from Taihe, China, has unique dark purple meat and black bone. It has been purposed to have special medicinal values and produce healthy eggs [16].

Table 1 Instrumental surface colour of breast meat from different lines of chicken

Parameter	WL	YO	HB	SEM
Lightness (*L**)	51.41 ^{b}	46.74 ^{c}	54.38 ^{a}	0.54
Redness (*a**)	5.08 ^{a}	2.88 ^{c}	3.68 ^{b}	0.22
Yellowness (*b**)	1.55 ^{b}	0.31 ^{c}	3.30 ^{a}	0.30
Hue angle (H^o)	20.51 ^{c}	336.30 ^{a}	56.18 ^{b}	31.63

SEM, standard error of the means; $^{a-c}$ Means within each row with different superscripts are significantly different ($p<0.05$)

Meat color is highly associated with the content of myoglobin and hemoglobin. Heme proteins content such as hemoglobin and myoglobin in meat contributes to the red colour of meat [17]. About two-thirds of iron in the body is found in hemoglobin, with smaller amounts found in myoglobin, iron-containing enzymes and transferrin [2]. Table 2 shows the amount of heme iron and non-heme (free) iron in breast meat extract from different lines of chicken. Although the redness of the meat differed among chicken lines, no differences were found on heme and non-heme iron content in this study ($p>0.05$). Previous study found that the heme and non-heme iron content vary among species and muscle type. Glycolytic muscle such as chicken breast meat has less heme iron than that of thigh meat, which is oxidative meat or so-called red meat [4].

Table 2 Iron content in breast meat from different lines of chicken

Parameter	WL	YO	HB	SEM
Heme iron (µg/g)	2.05	2.08	2.05	0.30
Free iron (µg/g)	0.21	0.22	0.20	0.06
Total iron (µg/g)	2.26	2.30	2.25	0.34
Free iron (%)	9.38	9.37	8.98	0.18

SEM, standard error of the means; Means within each row are not significantly different ($p>0.05$)

Oxidative processes lead to discoloration of meat. Therefore, the oxidative stability of meat and endogenous factors affecting it are important to be observed. Antioxidant enzymes activity has been extensively observed in meat from different species. Present study showed no differences ($p>0.05$) on the TBARS values were found among different lines, even though breast meat of YO had slightly higher malondialdehyde content than the others. Significant differences between lines were found on the activity of GSH-Px and SOD, whereas that of CAT showed no differences among chicken lines. Breast meat of YO had lower GSH-Px activity than other lines. Daun & Åkesson [18] found that GSH-Px activity vary among species of poultry. Both KNC shoed higher SOD activity than WL ($p<0.05$). Our results suggest that antioxidant enzymes activity may vary as well among different lines of chicken.

Table 3 Lipid oxidation and antioxidant enzymes activity in breast meat from different lines of chicken

Parameter	WL	YO	HB	SEM
TBARS (mg MA/kg)	0.53	0.61	0.57	0.02
CAT (U/g)	42.78	41.08	36.37	2.58
GSH-Px (U/g)	0.46 [a]	0.34 [b]	0.51 [a]	0.02
SOD (U/g)	90.28 [b]	102.62 [a]	95.29 [ab]	1.95

SEM, standard error of the means; [a-b] Means within each row with different superscripts are significantly different ($p<0.05$)

IV. CONCLUSION

Different genotypes had significant effects on breast meat pigmentation and the activity of GSH-Px and SOD. Korean native chickens may have higher antioxidant enzymes activity than white leghorn.

ACKNOWLEDGEMENT

This study was conducted with the support of research project (C1011157-01-01) from Rural Development Administration, Republic of Korea.

REFERENCES

1. Morrissey, P. A., Sheehy, P. J. A., Galvin, K., Kerry, J. P., & Buckley, D. J. (1998). Lipid stability in meat and meat products. Meat Science 49: 73-86.
2. Min, B., & Ahn, D. U. (2005). Mechanism of lipid peroxidation in meat and meat products-A review. Food Sci. Biotechnol. 14: 152-163.
3. Ji, L. L., Dillon, D., & Wu, E. (1991). Myocardial aging: antioxidant enzyme systems and related biochemical properties. American Journal of Physiology - Regulatory, Integrative and Comparative Physiology 261 (2): 386-392.
4. Chan, K. M., Decker, E. A., & Feustman, C. (1994). Endogenous skeletal muscle antioxidant. Critical Reviews in Food Science and Nutrition 34 (4): 403-426.
5. Hernández, P., Zomeño, L., Ariño, B., & Blasco, A. (2004). Antioxidant, lipolytic and proteolytic enzyme activities in pork meat from different genotypes. Meat Science 66 (3): 525-529.
6. Sinhuber, R. O., & Yu, T. C. (1977). The 2-thiobarbituric acid reaction, an objective measure of the oxidative deterioration occurring in fat and oil. J. Jap. Soc. Fish. Sci. 26: 259-267.
7. Aebi, H. (1984). Catalase *in vitro.* Meth. Enzym. 105: 121–126.
8. DeVore, V. R. & Greene, B. E. (1982). Glutathione-peroxidase in post-rigor bovine semi-tendinosus muscle. Journal of Food Science 47 (5): 1406–1409.
9. Marklund, S., & Marklund, G. (1974). Involvement of the superoxide anion radical in the autoxidation of pyrogallol and a convenient assay for superoxide dismutase. European Journal of Biochemistry 47: 469–474.
10. Hornsey, H. C. (1956). The colour of cooked cured pork I. Estimation of the nitric oxide-haem pigments. Journal of the Science of Food and Agriculture 7: 534–540.
11. Clark, E. M., Mahoney, A. W., & Carpenter, C. E. (1997). Heme and total iron in ready-to-eat chicken. Journal of Agricultural and Food Chemistry 45 (1): 124-126.
12. Carter, P. (1971). Spectrophotometric determination of serum iron at the submicrogram level with a new reagent (ferrozine). Anal. Biochem. 40: 450–458.
13. Ahn, D. U., Wolfe, F. H. & Sim, J. S. (1993). Three methods for determining non-heme iron in turkey meat. Journal of Food Science 58: 288–291.
14. Fletcher, D. L. 2002. Poultry meat quality. World's Poultry Science Journal 58 (2): 131-145.
15. Jaturasitha, S., Srikanchai, T., Kreuzer, M., & Wicke, M. (2008). Differences in carcass and meat characteristics between chicken indigenous to Northern Thailand (black-boned and Thai native) and imported extensive breeds (Bresse and Rhode Island Red). Poultry Science 87 (1): 160-169.
16. Koketsu, M. & Toyosaki, T. (2004). Nutritive constituents of Silky fowl eggs: comparison with hen eggs of White Leghorn origin. Animal Science Journal 75: 67–69.
17. Mancini, R. A. & Hunt, M. C. (2005). Current research in meat colour. Meat Science 71: 100–121.
18. Daun, C., & Åkesson, B. (2004). Comparison of glutathione peroxidase activity, and of total and soluble selenium content in two muscles from chicken, turkey, duck, ostrich and lamb. Food Chemistry 85 (2): 295-303.