EFFECT OF DIETARY SELENIUM ON QUALITY AND ANTIOXIDATION OF BROILER MEAT

Yoshinori Hashizawa*, Motoni Kadowaki, and Sinobu Fujimura
Graduate School of Science and Technology, Niigata University, 2-8050 Igarashi, Nishi-ku, Niigata, 950-2181, Japan
*Corresponding author (phone: +81-25-262-6674; fax: +81-25-262-6674; e-mail:f09l502a@mail.cc.niigata-u.ac.jp)

Abstract— This study focused on the effect of dietary selenium (Se) on meat quality, especially with regard to its water holding capacity (WHC), sensory score, and texture of stored meat. Furthermore, we examined the antioxidative effect of Se. As the resault, dietary Se significantly increased meat texture. This was new finding of Se function on meat quality. And also, Se increased glutathione peroxidase (GSHPx) activity on fresh tissue and stored 1 day for 4 ºC. Se was effective to prevent tissue oxidation, but it did not effect on stored tissue for 4 days at 4 ºC. From these results, it was demonstrated that dietary Se is a factor to improve meat quality.

***Index Terms*—meat quality, antioxidation, Selenium, feed**

I. INTRODUCTION

Recently attention to producing high quality meat or adding some functions on meat has increased in meat production industry. In connection with this, the impact of nutrients in animal feed on the quality of meat produced is being closely examined. Li *et al.*, (2009) have shown that dietary vitamin E reduced the drip loss, improved tenderness and prevented oxidation on poulty meat. Schwartz and Foltsz (1957) demonstrated that Se is indispensable in animal diets. Rotruck *et al.*, (1973) showed that Se is one element in GSHPx, an antioxidative enzyme found in the tissues of animals. If this enzyme is still functional in muscle before and/or after slaughtering, which can be expected that it would preserve the meat quality. Our study focused on the effect of dietary Se on meat quality, especially with regard to its WHC, sensory score, and meat texture. Furthermore, we examined the antioxidative effect of Se by GSHPx activity and TBARS on fresh and stored tissue.

II. MATERIALS AND METHODS

Animals and diets

1 day old Cobb strain female broilers ware obtained from a local hatchery. Chicks raised to 14 days in a warm chick brooder (30 ± 2 ºC). At 14 days, they were transferred to independent cages in a windowless room with controlled temperature (22 ± 2 ºC) and lighting (L:14, D:10). Diets and water were provided *ad libitum*.

In this study, two feeding trials were conducted. Experiment 1, seven days old broilers were divided to 4 groups (6 birds / group). Chemical compositions or nutrients of basal feed met with NRC requirements. Starter diet (from 7 days to 21 days) contained CP: 23%, ME: 3.2kcal / g and Se: 0.2 ppm. Finisher diet (from 21 days to slaughter) contained CP: 20%, ME: 3.2kcal / g and Se: 0.13 ppm. Group 1 chicks were fed only basal feed (Control), Group 2 were fed basal feed with additional Se 0.3 ppm (+Se 0.3) and Group 3 were fed with additional Se 1.0 ppm (+Se 1.0). Broilers were weighted and slaughtered at 41 days old. The pectoral muscle was removed immediately and stored at 4 ºC until determination of WHC and Sensory score. The abdominal fat was also removed immediately, and then froze by liquid nitrogen or after stored 4 ºC for 4 days kept in -20 ºC until determent of TBARS. In experiment 2, one day old broilers were divided to 2 groups with 2 levels of additional Se (0.0 or 1.0 ppm). The basal feed contained CP: 23%, ME: 3.2 kcal / g and Se: 0.12 ppm. Broilers were weighted and slaughtered at 29 days old. The pectoral muscle was removed immediately and stored at 4 ºC for 2 days until determent of meat texture. The liver was also removed immediately then froze by liquid nitrogen or stored at 4 ºC for 1 or 4 days. Then the liver samples were kept in -20 ºC until determent of GSHPx activity.

Meat quality

Breast muscle from chicks in Experiment 1 was analyzed for WHC and sensory score**.** Breast muscle preserved at 4 ºC for one day and muscle preserved for 4 days was used for WHC analysis. It was centrifuged at 1,000 x G (3,100rpm) at 4 ºC for 15 minutes. WHC was calculated from the difference in weight prior to centrifuging and after centrifuging;

WHC (%) = Wt2 /Wt1×100 ; Wt1: Weight (g) of sample prior to centrifuging; Wt2: Weight (g) of sample after centrifuging.

Breast muscle that had been preserved for 2 days at 4 ºC was used for sensory evaluation, by 12 trained panelists from Niigata University. The samples were estimated by the paired difference test, Scheffe's paired comparison test, and descriptive test (Imanari *et al.*, 2007).

Muscle from chicks in experiment 2 was preserved at 4 ºC for two days and then analyzed for meat physicality. The muscle samples were boiled by 70 ºC for 1 hour and then cutted 1 x 1x 1cm or 1 x 1 x 4cm. These pieces were measured shear force value, cutting response and hardness by Rheo-mater (Fudoh Rheo Meter RT-2005J, Rheotech Ltd., Japan).

Antioxidation

Samples taken from abdominal fat were analyzed for their level of lipid peroxidation using thiobarbituric acid reactive substance (TBARS). Liver samples from experiment 2 were analyzed for GSHPx activity as an indicator of antioxidant function. The mesods were based on Yoshida *et al.* (1981).

Statistic analysis

The date was compared using one-way ANOVA, where appropriate difference in group were compared using LSD.

III. RESULTS AND DISCUSSION

Meat samples stored for one day were compared WHC to control. In muscle obtained from chicks raised on + 0.3 Se diet, there was no significant difference in results; for muscle obtained from chicks raised on a diet containing 1.0 Se supplementation, WHC tended to increase by 1.02%. When stored for four days, showed insignificant increases in WHC of 1.01% and 1.02%, respectively. Though some differences were noted in WHC, there were no remarkable differences associated with either amount of Se supplementation or period of preservation.

Results for the paired difference test using +Se 1.0 and control meat was that 11 of 12 panelists noted difference in eating quality of the meat samples ($P < 0.01$). In the Scheffe's pair comparison test, the variance analysis was done to each parameter, and the main effects and the order effects were given to official approval. F value of the main effect of the taste, toughness, juiciness, and the overall preference were calculated and were 0.47, 0.24, 6.22, 1.44, and 0.88 respectively, and a significant difference was seen in only the toughness ($P < 0.05$). Futhermore, on the descriptive test, results were corresponed to above evaluation.

From the result of meat texture, shear force value was tend to increase about 62% on + Se 1.0 group. In cutting response, + Se 1.0 group was tend to increase about 33%. Each parameter was tend to increase on group added Se, compared with control group. These results showed that the overall texture of meat might be increased by adding the Se.

A decrease in the drip loss is reported as an effect of the Se addition (Choct and Naylor, 2004). On the other hand, in this study the tendency to increase on WHC by the Se addition is seen, though it was not significant. From the results of sensory evaluation, the main effect of the Se in the eating quality was explained to increase the hardness of meat. And then, this same effect was also explained in measurement of meat texture. This effect of Se have not known, and a new finding up to now.

Results for TBARS analysis, abdominal fat analyzed immediately after slaughter, was shown that tend to decrease about 15% for the +Se 0.3 group as compared to controls. The +Se 1.0 group demonstrated a significant decrease of about 54% ($P<0.05$). However, samples stored for 4 days showed no significant differences in the two Se supplemented groups. Results of the GSHPx when the liver samples stored 1 day were shown that + Se 0.3 group tend to increase about 21%. + Se 1.0 group was significantly increased about 45% ($P<0.05$).

Those means the effect of Se as an anti-oxide is very effective on living tissue or the early time after the slaughter. From this finging, it is important to understand that the feature of anti-oxides, and to chose which anti-oxide by the aim.

IV. CONCLUSION

From this study, dietary Se regulated the meat texture. This was new finding of Se function on meat quality. And also, Se was effective to prevent tissue oxidation, but it did not effect on stored tissue for 4 days at 4℃. Se increased GSHPx activity on fresh tissue and stored 1 day for 4℃.

REFERENCES

Avanzo JL, Mendonca Jr. CX, Pugine SMP and Cesar MC. (2001). Effect of vitamin E and Se on resistance to oxidative stress in chicken superficial pectoralis muscle. *Comp. Biochem. Phys*., **C129**, 163-173.

Aydemir T, Ozturk R, Bozkaya LA and Tarhan L. (2000). Effects of antioxidant vitamins A, C, E and trace elements Cu, Se on CuZnSOD, GSH-Px, CAT and LPO levels in chicken erythrocytes. *Cell Biochem. Funct*., **18**, 109-115 .

Choct M and Naylor AJ. (2004). The effect of dietary Se source and vitamin E levels on performance of male broilers. Asian-Aust. *J. Anim. Sci*., **17**, 1000-1006.

DeVore VR, Colnago GL, Jensen LS and Greene BE. (1983). Thiobarbituric acid values and glutathione peroxidase activity in meat from chicken fed a Se-supplemented diet. *J. Food Sci*., **48**, 300-301.

Downs KM, Hess JB and Bilgili SF. (2000). Se source effect on broiler carcass, characteristics, meat quality. *J. Appl. Anim. Res*., **18**, 61-72.

Edens FW, Carter TA and Sefton AE. (1996). Influence of dietary Se sources on post mortem drip loss from breast meat of broilers grown on different litters. *Poult. Sci*., **75**, 60.

Jenkinson SG, Lawrence RA, Byrk RF and Williams DW. (1982). Effects of copper deficiency on the activity of the selenoenzyme glutathione peroxidase on excretion and tissue retention of $^{75}SeO_3$. *J. Nutr*., **112**, 197-204 .

Imanari M, Kadowaki M and Fujimura S. (2007). Regulation of taste-active components of meat by dietary leucine. *Br. Poult. Sci*., **48**, 167-176.

Leeson S and Summers JD. (2001). Nutrition of the chicken 4th edn. University Books, Ontario. pp. 399-408.

Li WJ, Zhao GP, Chen JL, Zheng MQ and Wen J. (2009). Influence of dietary vitamin E supplementation on meat quality traits and gene expression related to lipid metabolism in the Beijing-you chicken. *Br. Poult. Sci*., **50**, 188-198

McDowell LR. (2003). Minerals in animal and human nutrition, 2nd edn. Elsevier Science B. V., Amsterdam. pp. 397-448.

Ozturk-Urek R, Bozkaya LA and Tarhan L. (2001). The effects of some antioxidant vitamin- and trace element-supplemented diets on activity of SOD, CAT, CSH-Px and LPO levels in chicken tissue. *Cell Biochem. Funct*. **19**, 125-132.

Yoshida M, Yasumoto K, Iwami K and Tashiro H. (1981). Distribution of selenium in bovine milk and selenium deficiency in rats fed casein-based diets, monitored by lipid peroxide level and glutathione peroxidase activity. *Agric. Biol. Chem*., **45**, 1681-1688.