Improvement of Meat Taste by Dietary Components

*Shinobu Fujimura and Motoni Kadowaki

(Received January 18, 2006)

Summary

Dietary nutrients play a significant part in determining growth rate and meat yield. It is known that the compositions of protein and total amino acids of meat are invariable by feeding treatments, hence the meat taste is considered to be invariable. However, the relationship of taste components of meat with nutrients is not fully elucidated, and there have been few reports on the effect of feeding treatments on taste-active components of chicken meat. Previously, restricted feeding and dietary low metabolizable energy levels decreased the free Glu contents of meat, and the meat taste was deteriorated (Fujimura *et al.*, 1997, 2001).

In the present study, the effect of dietary CP and amino acid levels before marketing on broiler meat composition, *i.e.*, free amino acids and ATP metabolites were studied using Cobb strain female broilers. As a result of this study, free Glu and sensory score in meat were increased in high CP diet, and free Glu contents increased by dietary CP levels for 3 to 10 days. Because the variation of the taste component improves the meat taste, the feeding condition is one of the important factors affecting the meat taste of chickens. For investigate the mechanism, Glu relate enzymes were analyzed. As a result, muscular Kidney type glutaminase (KGA) and glutamate dehydrogenase activities were changed by the dietary protein levels. Functional feedback regulation of KGA affected the Glu in muscle after 5 day, therefore, the short-time feeding of high CP diet, especially 3 to 5days, is more appropriate to improve the meat taste. These results suggest that meat taste can be improved by dietary components.

Bull.Facul.Agric.Niigata Univ., 58(2):151-153, 2006

Key words : Diet, protein, leucine, meat, taste

Dietary nutrients play a significant part in determining growth rate and meat yield. It is known that the compositions of protein and total amino acids of meat are invariable by feeding treatments, hence the meat taste is considered to be invariable. However, the relationship of taste components of meat with nutrients is not fully elucidated, and there have been few information on its taste-related components of chicken meat for evaluation of meat quality.

Amino acids and peptides play a major role in eliciting the characteristic taste of foods. It is also known that the meat aroma is influenced by dietary composition, especially fatty acids. In the previous reports, we identified three compounds, *i.e.*, free glutamic acid (Glu), 5'-inosinic acid (IMP) and potassium ion, as taste active components in the chicken meat extract (Fujimura *et al*., 1995, 1996). Glu and IMP, called as 'umami' taste, are favorites for consumers and constitute a characteristic taste of chicken meat. If the amount of these taste active compounds in the edible portion of livestock could be controlled by feeding, the meat taste could be altered.

Previously, we obtained the results that feed restriction for 5 weeks and exercise altered free Glu, of the chicken meat, although they did neither affect total Glu of meat protein, nor the contents of total protein, amino acids, lipid, fatty acids and ash of meat (Fujimura *et al.*, 1997, 2001). Those results indicated that feeding condition could affect the meat taste of broilers.

In this study, the relationship of dietary crude protein (CP) and amino acid levels with taste components in chicken meat extract was studied, focusing in particular on the taste-active components. As a result, meat taste were improved by the dietary protein and amino acid levels, and then Glu regulation mechanism was studied by Glu-relate enzymes in muscle. Four experiments were conducted, Experiment 1: meat type chickens were fed graded CP level diets for 10 days, and the meat composition, free amino acids and ATP metabolites were measured at 0, 3, 5 and 10 days. Experiment 2: the effect of dietary BCAA, especially leucine (Leu), level on meat quality was studied at 10 days. Experiment 3: meat taste was evaluated by sensory evaluation. Experiment 4: Glu-related enzymes of meat in different CP levels were measured at 0, 3, 5 and 10 days.

Materials and methods

Experiment 1: The 14-day-old female Cobb strain broiler chickens were divided into four groups with twelve chicks in each group. The chicks were fed CP 17.6 (control), 26.3, 30.7 and 35.1% diet. All the chickens were kept in individual wire cages. Free amino acids and ATP metabolites of the breast muscle (*M. Pectoralis superficialis*) extract were measured at 0, 3, 5 and 10 days.

Experiment 2: The 28-day-old female Cobb strain broiler chickens were divided into 4 groups. Leu contents of

Department of Applied Biological Chemistry, Faculty of Agriculture, Niigata University, Niigata 950-2181, Japan
*Corresponding author: fujimura@agr.niigata-u.ac.jp

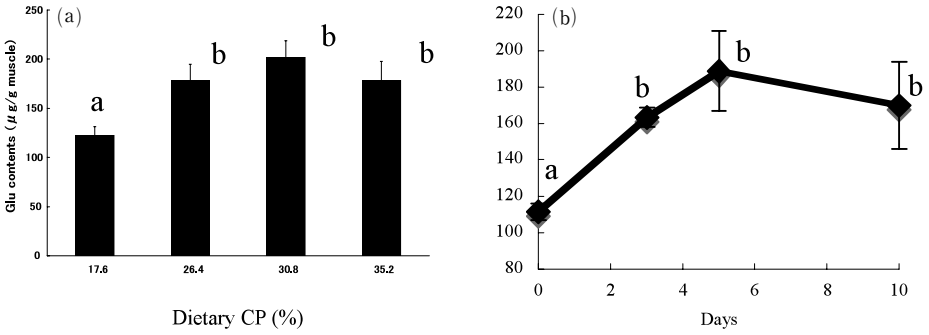

Fig. 1 Effect of (a) graded CP levels and (b) CP 37.5% diet on free Glu contents of pectoral muscle extract. Values are means ± SE (n=6, P<0.01).

experimental diet were 70, 100, 130 (control) and 150% of NRC (1994) requirement of Leu. Because commercial diets include 130-150% of NRC requirement, we considered Leu130% as control. The 4 groups of chickens were allowed free access to each of these diets for 10 days. On 11th day, all of the chickens were killed, and then breast muscle (*M. Pectoralis superficialis*) was taken for following analyses. Concentrations of free amino acids and ATP metabolites in meat extract were measured by HPLC (Shimadzu LC-10A, Kyoto).

Experiment 3: Two sensory evaluations, paired comparison test and Scheffe's paired difference test, were conducted between meats of CP17.5% (Control) and 30.7% groups.

Experiment 4: The 14-day-old broiler chicks were fed CP 30.7% diet for 10 days. At 0, 3, 5 and 10 days, Glu-relate enzymes in muscle were measured. For the investigation of Glu regulation mechanism, glutamate dehydrogenase (GDH), kidney type glutaminase (KGA), glutamine synthetase (GS) and alanine transaminase (ALT) activities were measured by enzymatic methods (Bergmeyer, 1974).

Results and discussion

In Experiment 1, free Glu of meat significantly increased in the high CP diet (Fig. 1(a)), while IMP was invariable. And, free Glu of muscle after 3 and 5 days feeding of high CP diet was higher than that of 0 day (P<0.01), and tended to decrease after 5 day (Fig. 1(b)). In Experiment 2, the muscle amino acid analysis showed that free Leu contents increased with an increase in dietary Leu level. On the other hand, free Glu contents of the Leu100% diet increased by 34% compared to that of the control (Leu130%, P<0.05). With a decrease in dietary Leu levels, free Glu of muscle had tended to increase (Fig. 2). There were no differences in the IMP contents of muscle in all groups. Because free Glu contents of meat were above the taste threshold value of Glu, these variations were considered to have affected the meat taste.

In the sensory evaluation (Experiment 3), a significant difference showed that in the paired comparison test (P<0.01). The result of the paired comparison test, the taste of the meat in the high CP diet group was superior to that in the

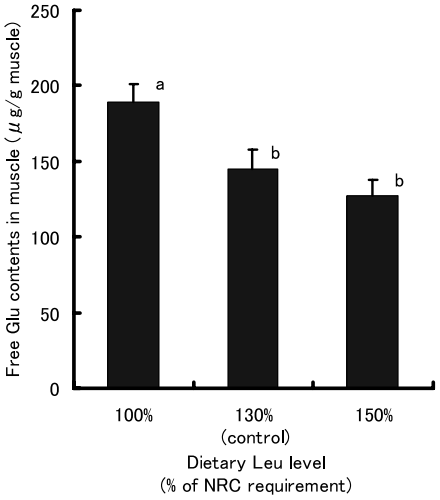

Fig. 2 Effect of dietary Leu levels on free Glu contents in chick muscle. Values are means ± SE (n=6). Bars with different letters,[a,b] are significantly different (P < 0.05).

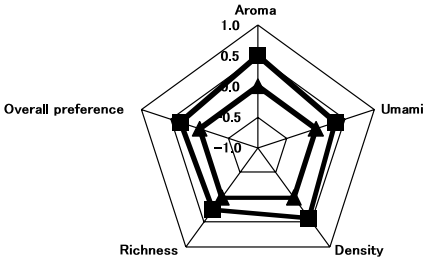

Fig. 3 Scheffe's paired difference test between pectoral meat extracts of CP 17.6 and 30.7% diets.

control group, especially overall preference, density and umami taste (Fig. 3). These results suggested that, dietary CP levels could affect taste-active components, especially free Glu. The taste of meat in Leu100% group was also superior to that in the control group (data not shown).

In experiment 4, at 3 day, KGA activity in muscle of

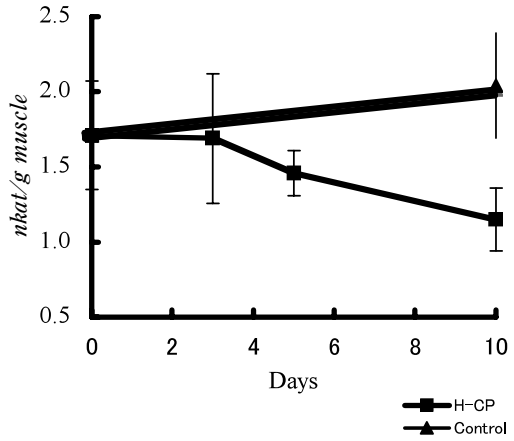

Fig. 4 Effect of dietary CP levels on glutaminase activity of pectoral muscle. Values are means ± SE (n=6, P<0.01).

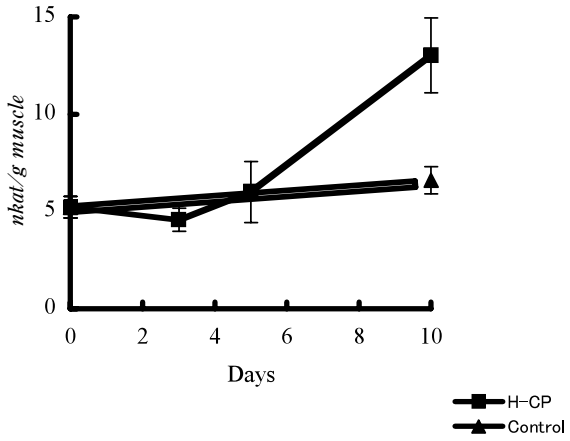

Fig. 5 Effect of dietary CP levels on GDH activity of pectoral muscle. Values are means ± SE (n=6, P<0.01).

CP 30.7% diet was lower than that of control (Fig. 4, P<0.01). GDH activity in CP 30.7% diet was tended to increase after 5 days (Fig. 5). There were no differences in GS and ALT activities. KGA was considered to contribute to the free Glu increase. And feedback inhibition of KGA activity by high Glu concentration at 5 day may have affected the free Glu concentration of muscle at 10 day.

As a result of this study, we concluded that feed composition, CP and amino acids, regulate the meat taste, and short time feeding of high CP diet was appropriate to increase the free Glu and sensory score of meat.

Conclusions

In order to elucidate the factors affecting the taste of chicken meat, the effect of dietary CP and amino acid levels before marketing on broiler meat composition, *i.e.*, free amino acids, and ATP metabolites, and regulation mechanism were studied using Cobb strain female broilers. As a result of this study, free Glu and sensory score in meat were increased by dietary CP and leucine levels. Because the variation of the taste component improves the meat taste, the dietary component is one of the important factors affecting the meat taste of chickens. Muscular KGA and GDH activities were changed by the dietary proteins. Functional feedback regulation affected the Glu in muscle after 5 day, therefore, the short time feeding of high CP diet, especially for 3 to 5 days, is more appropriate to improve the meat taste. The Glu level and sensory score were also changed by dietary Leu level.

References

Bergmeyer, HU. 1974. *Methods of Enzymatic Analysis*. 2nd ed. Academic Press. New York.

Fujimura, S., S. Kawano, H. Koga, H. Takeda, M. Kadowaki and T. Ishibashi. 1995. Identification of taste-active components in the chicken meat extract by omission test - Involvement of glutamic acid, IMP and potassium ion. *Anim. Sci. Technol. (Jpn.)*, 66: 43-51.

Fujimura, S., H. Koga, H. Takeda, N. Tone, M. Kadowaki and T. Ishibashi. 1996. Role of taste-active components, glutamic acid, 5'-inosinic acid and potassium ion in taste of chicken meat extract. *Anim. Sci. Technol. (Jpn.)*, 67: 423 -429.

Fujimura, S., F. Sakai and M. Kadowaki. 2001. Effect of restricted feeding before marketing on taste active components of broiler chickens. *Anim. Sci. J.*, 72(3): 223-229.

Fujimura, S., A. Eguchi, T. Kobayashi, F. Sasaki and M. Kadowaki. 2004. Regulation of taste-active components of meat by dietary protein levels. *Proc. 50th Int. Cong. Meat Sci. Technol.*, 1276-1277.

Imanari, M., M. Kadowaki and S. Fujimura, 2004. Regulation of taste-active components of meat by dietary branched-chain amino acids. *Proc. 50th Int. Cong. Meat Sci. Technol.*, 1282-1283.

Zhou X and Thompson JR. 1996. Regulation of glutamate dehydrogenase by branched-chain amino acids in skeletal muscle from rats and chicks. *Int. J. Biochem.*Cell Boil, 28(7): 787-793.