# 飼料のアミノ酸および代謝エネルギー水準が比内鶏の生産性におよぼす影響



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# Effects of Dietary Amino Acid and Metabolizable Energy Levels on Performance of Native Chicken, Hinai-dori

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The present study was conducted to study the effects of dietary amino acid and metabolizable energy (ME) levels on the performance of Hinai-dori at different ages, and to obtain the basic information of Hinai-dori preceding a series of experiment to determine the requirement of individual essential amino acids.

Three Hinai-dori chicks of both sexes per dietary group were confined individually in wire cages and were fed the experimental diets *ad libitum* from 7 to 21, 42 to 56 and 77 to 91 days of age in Experiments 1, 2 and 3, respectively. Experiments have a 3×5 factorial arrangement of treatment with three ME and five amino acid levels. The body weight and feed intake were recorded on the 14th day on the experimental diet.

There was no sexual difference in the response to dietary amino acid and ME levels for any of the parameters determined. The body weight gain and feed efficiency were improved with increasing of amino acid levels. The feed intake was not affected by amino acid levels. The body weight gain, feed efficiency and feed intake were not affected by ME levels. The amino acid level for the maximum body weight gain and feed efficiency decreased with age. The maximum body weight gain was observed at the period from 42 to 56 days of age.

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**Key wowrds** : Hinai-dori, amino acid level, energy level, performance

## Introduction

Hinai-dori is one of the special natural treasures reared in Hinai area in north Akita Prefecture. Since the meat of Hinai-dori is very tasty, the crossbred of Rhode Island Red×Hinai-dori (Hinai-dori) is produced specially for local dishes, Kiritampo. FUJIMURA *et al.* (1991) have proved that the meat of Hinai-dori is more tasteful than that of broiler, and then set up the temporary amino acid requirements of Hinai-dori from the comparison of growth ratio among Hinai-dori, broiler and layer-strain pullet. The growth rate of Hinai-dori was faster 30% than layer-strain pullet and slower 20% than broiler at 5 weeks of age. Therefore, the temporary amino acid requirements were estimated by a following equation :

Hinai-dori=layer-strain pullet+(broiler-layer-strain pullet)/3 ··············(1)

Where Hinai-dori represents the temporary amino acid requirements of Hinai-dori. Layer-strain pullet and broiler are the amino acid requirements of layer-strain pullet and broiler recommended by the NRC (1984), respectively. The difference of metabolizable energy (ME) level was not corrected. The amino acid requirements are affected by various factors such as ages, dietary ME, dietary crude protein (CP), sources of CP, species, physiological conditions of animals and criteria employed, and so on.

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The present study was conducted to study the effects of dietary amino acid and ME levels on the performance of Hinai-dori at different ages, and to obtain the basic information of Hinai-dori preceding a series of experiment to determine the requirement of individual essential amino acids.

## Materials and Methods

1. Animals. Experiment 1 : One hunderd and fifty fertilized eggs (Rhode Island Red×Hinai-dori) produced at Akita Prefectural Livestock Experiment Station were incubated in an incubator in our laboratory. After hatching, one-day-old chicks were sex-sorted and were fed a commercial diet containing 20% CP and 2,900 kcal ME/kg of diet for 7 days. After then, they were assigned to 15 experimental groups of 3 chicks of both sexes each with the same average body weights. The initial body weights of male and female were 87.9 and 83.5 g, respectively. The spared chicks which were not used for the experiment were fed the commercial diet continuously. During the assay period, the chicks were confined individually in the thermo-controlled wire cages and were fed the experimental diets and water *ad libitum* under the condition of 14 hrs light and 10 hrs dark in a room maintained at 22-25℃. On the 14th day on the experimental diets, the body weight gain and feed intake were recorded.

Experiemnt 2 : After Experiment 1, all chicks used for the experiment were mixed with the spared chicks and were fed the commercial diet further for 21 days. On the 42nd day after hatching, the chicks were allotted again to 15 experimental groups of 3 chicks of both sexes each in the same way as in Experiemnt 1 and were supplied the experimental diets for 14 days. The initial body weights of male and female were 673.0 and 577.1 g, respectively. They were raised in wire cages individually for 14 days in the same way as in Experiment 1. The body weight and feed intake were recorded on 14th day on the experimental diet.

Experiment 3 : After Experiemnt 2, all chicks were mixed with the spared chicks and were fed the commercial diet for 21 days. On the 77th day after hatching, the chicks were assigned to 15 experimental groups of 3 chicks of both sexes each and reared in the same way as in the previous experiments until 91 days old. The initial body weights of male and female were 1499.6 and 1171.8 g, respectively.

2. Diets. The compositions of four basal diets used in Experiments 1, 2 and 3 are shown in Tables 1, 2 and 3, respectively. The diets in Tables 1 to 3 were formulated to contain all nutrients except amino acids not less than those requirement levels calculated from the NRC (1984) requirements using the equation (1). Diets No. 1, 5, 11 and 15 contained low amino acid and low ME, high amino acid and low ME, low amino acid and high ME and high amino acid and high ME, respectively. Diets 1 and 5, and diets 11 and 15 in each Table were mixed at the ratio 3 to 1, 2 to 2, and 1 to 3 to make diets 2 to 4, and diets 12 to 14, respectively. Diets 6 to 10 were prepared by mixing diets 1 and 11, diets 2 and 12, diets 3 and 13, diets 4 and 14, and diets 5 and 15 in each Table at the ratio 1 to 1, respectively. Four amino acids ; arginine, lysine, methionine and threonine, were added to meet the amino acid requirement levels calculated from the NRC requirements using the equation (1). The temporary amino acid requirements of

Table 1. Composition of experimental diets during period from 7 to 21 days of age(%)

| Diet No.<br>Ratio to standard (%)[1] | 1<br>80 | 5<br>120 | 11<br>90 | 15<br>130 |
|---|---|---|---|---|
| Corn | 56.165 | 50.518 | 67.732 | 61.549 |
| Wheat bran | 27.00 | 18.40 | 10.00 | 1.00 |
| Soybean meal (44.0% CP) | 7.80 | 18.10 | 9.20 | 20.00 |
| Fish meal (62.6% CP) | 3.90 | 8.80 | 4.60 | 10.00 |
| Soybean oil | 1.00 | 1.00 | 4.00 | 4.00 |
| $CaCO_3$ | 1.50 | 0.70 | 1.50 | 0.70 |
| $CaHPO_4$ | 2.00 | 1.80 | 2.00 | 1.80 |
| Amino acid mixture | 0.135 | 0.182 | 0.468 | 0.451 |
| L-Arginine | — | — | 0.112 | 0.119 |
| L-Lysine-HCl | 0.076 | 0.005 | 0.174 | 0.068 |
| L-Methionine | 0.058 | 0.142 | 0.125 | 0.192 |
| L-Threonine | 0.001 | 0.035 | 0.057 | 0.072 |
| NaCl | 0.20 | 0.20 | 0.30 | 0.30 |
| Vitamin-mineral mixture[2] | 0.20 | 0.20 | 0.20 | 0.20 |
| Choline-Chloride | 0.10 | 0.10 | 0.10 | 0.10 |
| CP (%) | 15.12 | 20.93 | 14.90 | 21.08 |
| ME (kcal/kg) | 2770 | 2770 | 3150 | 3150 |

[1] Percentage of temporary amino acid requirements of Hinai-dori by FUJIMURA *et al.* (1991).

[2] 1kg vitamin-mineral premix contained V.A, 429IU; V.$D_3$, 57.2IU; DL-$\alpha$-tocopherol acetate, 2.86g; thiamine nitrate, 0.514g; menadion 0.143g; riboflavin, 1.029g; pyridoxine-Cl, 0.857g; nicotinic acid amide, 7.65g; Ca pantothenate, 3.11g; folic acid, 157mg; d-biotin, 42.9mg cyanocobalamine, 2.57mg; $MnSO_4$, 47.1g; $FeSO_4$, 62.2g; $CuSO_4$, 5.74g; $ZnCO_3$, 11.43g; $Ca(IO_3)_2\,6H_2O$, 0.1536g and $MgCO_3$, 171.4g.

Table 2. Composition of experimental diets during period from 7 to 21 days of age (%)

| Diet No.<br>Ratio to standard (%)[1] | 1<br>60 | 5<br>100 | 11<br>70 | 15<br>110 |
|---|---|---|---|---|
| Corn | 63.768 | 60.686 | 74.616 | 70.856 |
| Wheat bran | 29.50 | 22.00 | 12.90 | 3.80 |
| Soybean meal (44.0% CP) | — | 7.30 | 3.70 | 12.00 |
| Fish meal (62.6% CP) | — | 3.20 | — | 4.60 |
| Soybean oil | 1.00 | 1.00 | 3.00 | 3.00 |
| $CaCO_3$ | 2.50 | 2.50 | 2.50 | 2.50 |
| $CaHPO_4$ | 2.50 | 2.50 | 2.50 | 2.50 |
| Amino acid mixture | 0.082 | 0.164 | 0.134 | 0.094 |
| L-Arginine | — | — | — | 0.005 |
| L-Lysine-HCl | 0.082 | 0.048 | 0.114 | — |
| L-Methionine | — | 0.053 | 0.008 | 0.050 |
| L-Threonine | — | 0.063 | 0.012 | 0.039 |
| NaCl | 0.20 | 0.20 | 0.20 | 0.20 |
| Vitamin-mineral mixture[2] | 0.35 | 0.35 | 0.35 | 0.35 |
| Choline-Chloride | 0.10 | 0.10 | 0.10 | 0.10 |
| CP (%) | 10.23 | 14.07 | 10.30 | 15.05 |
| ME (kcal/kg) | 2800 | 2800 | 3100 | 3100 |

[1,2] See footnotes in Table 1.

Table 3. Composition of experimental diets during period from 77 to 91 days of age (%)

| Diet No.<br>Ratio to standard (%)[1] | 1<br>69 | 5<br>109 | 11<br>75 | 15<br>115 |
|---|---|---|---|---|
| Corn | 62.790 | 56.510 | 82.354 | 73.701 |
| Wheat bran | 26.40 | 23.10 | 8.50 | 6.40 |
| Soybean meal (44.0% CP) | — | 8.40 | 3.80 | 9.90 |
| Fish meal (62.6% CP) | — | 3.00 | — | 4.10 |
| Cellulose | 4.80 | 4.20 | — | — |
| Soybean oil | 1.00 | 1.00 | 1.00 | 2.00 |
| $CaCO_3$ | 1.50 | 0.90 | 1.20 | 1.00 |
| $CaHPO_4$ | 2.70 | 2.10 | 2.40 | 2.10 |
| Amino acid mixture | 0.160 | 0.140 | 0.096 | 0.149 |
| L-Arginine | — | — | 0.003 | 0.034 |
| L-Lysine-HCl | 0.108 | — | 0.091 | — |
| L-Methionine | 0.014 | 0.065 | — | 0.058 |
| L-Threonine | 0.038 | 0.075 | 0.002 | 0.057 |
| NaCl | 0.20 | 0.20 | 0.20 | 0.20 |
| Vitamin-mineral mixture[2] | 0.35 | 0.35 | 0.35 | 0.35 |
| Choline-Chloride | 0.10 | 0.10 | 0.10 | 0.10 |
| CP (%) | 9.73 | 14.20 | 10.32 | 14.53 |
| ME (kcal/kg) | 2700 | 2700 | 3100 | 3100 |

[1,2] See footnotes in Table 1.

Table 4. The temporary amino acid requirements of Hinai-dori as percentages of diet

| | Weeks | | |
|---|---|---|---|
| Amino acids | 1-3 | 6-8 | 11-13 |
| Arginine | 1.15 | 0.89 | 0.83 |
| Glycine+Serine | 0.96 | 0.62 | 0.58 |
| Histidine | 0.29 | 0.23 | 0.22 |
| Isoleucine | 0.67 | 0.53 | 0.50 |
| Leucine | 1.12 | 0.89 | 0.83 |
| Lysine | 0.97 | 0.68 | 0.60 |
| Methionine+Cystine | 0.71 | 0.53 | 0.50 |
| Methionine | 0.37 | 0.27 | 0.25 |
| Phenylalanine+Tyrosine | 1.11 | 0.89 | 0.83 |
| Phenylalanine | 0.60 | 0.48 | 0.45 |
| Threonine | 0.72 | 0.61 | 0.57 |
| Tryptophan | 0.19 | 0.15 | 0.14 |
| Valine | 0.69 | 0.55 | 0.52 |

Hinai-dori are shown in Table 4.

3. Statistical analysis. Statistical significance was determined by analysis of variance and Duncan's new multiple range test using the general linear model procedure of Statistical Analysis System (SAS institute, 1985). Statements of significance are based upon $P<0.05$ unless otherwise stated.

## Results

The results obtained are summarized in Tables 5, 6 and 7. In all experiments, there were no interactions of ME levels, amino acid levels, or ME levels×amino acid levels with sex of Hinai-dori, which indicating that there were no differences between sexes to the dietary factors, amino acid and ME levels. The body weight gain and feed efficiency increased significantly with increasing of amino acid levels and then reached maximum levels at each ME level. The feed intake was not affected by both amino acid and ME levels. Therefore, the amino acid requirements were estimated as a minimum level which the body weight gain and feed efficiency reached to the maximum levels.

The body weight gain and feed efficiency of both sexes of Hinai-dori in Experiment 1 are shown in Table 5. In the male chicks, amino acid levels for the maximum body weight gain and feed efficiency were estimated to be 120, 115 and 130% at 2,776, 2,965 and 3,155 kcal ME/kg of diet, respectively. In the female chicks, those for the maximum body weight gain were estimated to be 120 and 115% at 2,776 and 2,965 kcal ME/kg of diet, respectively. The body weight gain at 3,155 kcal ME/kg of diet was not significantly affected by the dietary amino acid levels. Those for the maximum feed

Table 5. Performance of male and female Hinai-dori fed diets with 3 ME levels and 5 amino acid levels during period from 7 to 21 days of age[1]

| Diet No. | ME level (kcal/kg) | Ratio to standard(%)[2] | Body weight gain (g) | | Feed intake (g) | | Feed efficiency (gain : feed) | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Male | Female | Male | Female |
| 1 | 2.770 | 80 | 145.5$^{c}$ | 129.0$^{b}$ | 352.3 | 324.6 | .414$^{b}$ | .397$^{b}$ |
| 2 | 2,770 | 90 | 168.9$^{b}$ | 145.7$^{ab}$ | 381.5 | 332.3 | .443$^{ab}$ | .439$^{b}$ |
| 3 | 2,770 | 100 | 184.9$^{a}$ | 146.2$^{ab}$ | 376.1 | 331.2 | .492$^{a}$ | .442$^{b}$ |
| 4 | 2,770 | 110 | 168.9$^{b}$ | 141.8$^{b}$ | 360.4 | 323.6 | .470$^{ab}$ | .436$^{b}$ |
| 5 | 2,770 | 120 | 183.1$^{a}$ | 170.1$^{a}$ | 372.6 | 345.0 | .494$^{a}$ | .493$^{a}$ |
| | Pooled SE | | 4.1 | 4.6 | 5.2 | 5.2 | .011 | .010 |
| 6 | 2,960 | 85 | 165.6$^{b}$ | 147.7$^{b}$ | 361.9 | 340.5 | .458$^{b}$ | .435$^{c}$ |
| 7 | 2,960 | 95 | 170.7$^{b}$ | 155.5$^{ab}$ | 383.3 | 351.6 | .445$^{b}$ | .443$^{c}$ |
| 8 | 2,960 | 105 | 171.2$^{b}$ | 164.4$^{ab}$ | 361.5 | 364.0 | .474$^{b}$ | .453$^{bc}$ |
| 9 | 2,960 | 115 | 194.7$^{a}$ | 170.4$^{a}$ | 378.0 | 340.5 | .515$^{a}$ | .501$^{a}$ |
| 10 | 2,960 | 125 | 191.1$^{a}$ | 158.2$^{ab}$ | 368.4 | 328.1 | .518$^{a}$ | .482$^{ab}$ |
| | Pooled SE | | 3.6 | 2.9 | 3.5 | 6.4 | .009 | .008 |
| 11 | 3,150 | 90 | 174.6$^{b}$ | 142.9 | 368.1$^{a}$ | 316.3 | .474$^{c}$ | .452$^{b}$ |
| 12 | 3,150 | 100 | 184.9$^{b}$ | 162.9 | 372.5$^{a}$ | 332.6 | .496$^{bc}$ | .490$^{ab}$ |
| 13 | 3,150 | 110 | 184.9$^{b}$ | 168.2 | 356.8$^{ab}$ | 331.0 | .518$^{b}$ | .508$^{a}$ |
| 14 | 3,150 | 120 | 171.5$^{b}$ | 160.4 | 335.7$^{b}$ | 321.5 | .511$^{b}$ | .499$^{a}$ |
| 15 | 3,150 | 130 | 208.2$^{a}$ | 163.1 | 362.3$^{a}$ | 318.2 | .574$^{a}$ | .511$^{a}$ |
| | Pooled SE | | 4.1 | 3.9 | 4.4 | 4.2 | .010 | .007 |

$^{a-c}$Means in the same columns with no common superscripts are significantly different ($P<.05$).

[1]Values are means of three birds.

[2]Percentage of temporary amino acid requirements of Hinai-dori by FUJIMURA *et al.* (1991).

efficiency were estimated to be 120, 115 and 110% at 2,776, 2,965 and 3,155 kcal ME/kg of diet, respectively.

The results of Experiment 2 are shown in Table 6. The body weight gain and feed efficiency of both sexes at all ME levels were signifiacntly affected by the dietary amino acid levels. In the male chicks, the amino acid levels for the maximum body weight gain were estimated to be 90, 95 and 110%, respectively, and those for the feed efficiency were estimated to be 90, 105 and 110% at 2,800, 2,951 and 3,102 kcal ME/kg of diet, respectively. In the female chicks, those for the maximum body weight gain were estimated to be 90, 105 and 100% at 2,800, 2,951 and 3,102 kcal ME/kg of diet, respectively, and those for the maximum feed efficiency were estimated to be 100, 105 and 110% at 2,800, 2,951 and 3,102 kcal ME/kg of diet, respectively.

The results of Experiment 3 are shown in Table 7. The amino acid levels for maximum body weight gain and feed efficiency of male were estimated to be 99, 102 and 105% at 2,702, 2,902 and 3,101 kcal ME/kg of diet, respectively. In the case of female chicks, those for maximum body weight gain were estimated to be 99, 112 and 95% at 2,702, 2,900 and 3,101 kcal ME/kg of diet, respectively. Those for maximum feed efficiency were estimated to be 99 and 85% at 2,702 and 3,100 kcal ME/kg of diet, respectivbely, and those for maximum feed efficiency at 2,900 kcal ME/kg of diet were not significantly affected by the dietary amino acid levels.

## Discussion

It had long been believed that male and female broilers might have different amino acid requirements in spite of that the same diets for both sexes of broilers are recommended by the NRC (1984) and Japanese Feeding Standard for Poultry (1984). Recently, WALDROUP *et al.* (1990) investigated the sexual difference in the response to dietary energy and amino acid levels in broilers, and concluded that there was no sexual difference in the response to them for any of the parameters in their studies. Their result agreed well with the reports by DOUGLAS and HARMS (1960), COMBS and NICHOLSON (1965), BORNSTEIN and LIPSTEIN (1966), and FREEMAN (1979). The data of Hinai-dori obtained here also agreed with the above reports. It was desirable that there was no sexual difference in the nutritional requirements, because in the commercial farm, male and female Hinai-dori were reared together till reach to the market weight. Therefore, the amino acid requirements of Hinai-dori were expressed as the minimum amino acid levels for both sexes for maximal performance at each ME level at three ages in the followings.

The amino acid levels for the maximum performance for 7 to 21 days of age at 2,770, 2,960 and 3,150 kcal ME/kg of diet were estimated to be 120, 115 and 130%, respectivley. Those for 42 to 56 days of age at 2,800, 2,950 and 3,150 kcal ME/kg of diet were 90, 105 and 110%, respectively. Those for 77 to 91 days of age at 2,700, 2,900 and 3,100 kcal ME/kg of diet were 99, 102 and 105%, respectively. These values showed that the amino acid requirements of Hinai-dori declirned with age as observed in broiler chicks by BOOMGAARDT and BAKER (1972), POWELL and GEHLE (1974), YULE (1976), PROUDFOOT and HULAN (1980), ROUSH (1982) and KOIDE *et al.* (1993). The present study

Table 6. Performance of male and female Hinai-dori fed diets with 3 ME levels and 5 amino acid levels during period from 42 to 56 days of age[1]

| Diet No. | ME level (kcal/kg) | Ratio to standard(%)[2] | Body weight gain (g) | | Feed intake (g) | | Feed efficiency (gain : feed) | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Male | Female | Male | Female |
| 1 | 2,800 | 60 | 180.9$^{c}$ | 125.5$^{c}$ | 982.0 | 845.9 | .184$^{c}$ | .149$^{c}$ |
| 2 | 2,800 | 70 | 206.9$^{c}$ | 206.0$^{b}$ | 1013.2 | 982.2 | .205$^{c}$ | .210$^{b}$ |
| 3 | 2,800 | 80 | 266.6$^{b}$ | 201.1$^{b}$ | 1032.4 | 888.6 | .258$^{b}$ | .227$^{ab}$ |
| 4 | 2,800 | 90 | 344.4$^{a}$ | 218.9$^{a}$ | 1176.6 | 930.8 | .293$^{a}$ | .239$^{ab}$ |
| 5 | 2,800 | 100 | 331.4$^{a}$ | 242.6$^{a}$ | 1154.5 | 895.8 | .288$^{ab}$ | .270$^{a}$ |
| | Pooled SE | | 18.5 | 11.6 | 33.8 | 26.0 | .012 | .012 |
| 6 | 2,950 | 65 | 224.5$^{c}$ | 111.1$^{c}$ | 1062.5 | 754.3$^{b}$ | .213$^{d}$ | .148$^{c}$ |
| 7 | 2,950 | 75 | 251.7$^{bc}$ | 221.3$^{b}$ | 1071.8 | 985.9$^{a}$ | .236$^{cd}$ | .225$^{b}$ |
| 8 | 2,950 | 85 | 291.9$^{ab}$ | 224.0$^{b}$ | 1119.1 | 913.2$^{ab}$ | .262$^{bc}$ | .245$^{b}$ |
| 9 | 2,950 | 95 | 323.7$^{a}$ | 218.9$^{b}$ | 1130.0 | 840.7$^{ab}$ | .287$^{ab}$ | .260$^{b}$ |
| 10 | 2,950 | 105 | 333.8$^{a}$ | 252.3$^{a}$ | 1065.5 | 786.8$^{b}$ | .313$^{a}$ | .325$^{a}$ |
| | Pooled SE | | 12.8 | 13.8 | 29.0 | 29.8 | .011 | .016 |
| 11 | 3,100 | 70 | 243.8$^{c}$ | 148.9$^{c}$ | 950.2 | 859.8 | .258$^{c}$ | .172$^{d}$ |
| 12 | 3,100 | 80 | 279.8$^{bc}$ | 248.8$^{b}$ | 1097.5 | 902.9 | .257$^{c}$ | .276$^{c}$ |
| 13 | 3,100 | 90 | 295.8$^{b}$ | 233.5$^{b}$ | 1091.3 | 849.1 | .271$^{bc}$ | .275$^{bc}$ |
| 14 | 3,100 | 100 | 321.8$^{ab}$ | 243.0$^{b}$ | 1038.3 | 832.7 | .311$^{a}$ | .292$^{ab}$ |
| 15 | 3,100 | 110 | 350.6$^{a}$ | 278.1$^{a}$ | 1086.0 | 828.5 | .323$^{a}$ | .336$^{a}$ |
| | Pooled SE | | 11.4 | 13.0 | 26.7 | 12.3 | .009 | .016 |

[a-d, 1, 2] See footnotes in Table 5.

suggested that the temporary amino acid requirements calculated by the equation (1) might be low for the maximum performance of Hinai-dori except for 77 to 91 days of age.

Though the body weight gain of broiler and layer-strain pullet might be maximized at period from 28 to 42 days of age (NRC, 1984), that of Hinai-dori might be maximized at the period from 42 to 56 days of age (Tables 1, 2 and 3). The different breeds might have the different growth ratio, and the period when the growth ratio of Hinai-dori reached the plateau might be later than that of broiler and layer-strain pullet. Because the amino acid requirements might be chiefly affected by the protein synthesis for growth, the amino acid requirements were high when the growth ratio was fast. Therefore, the amino acid requirements estimated in the present study might be higher than the temporary requirements using the requirements of layer-strain pullet and broiler till the growth ratio of Hinai-dori reached to the plateau. The amino acid requirements estimated in the present study for 77 to 91 days of age might agree well with the temporary requirements.

Because the feed intake was controlled primarily by energy needs of animals, it has been observed that feed intake decreased with increasing dietary ME levels, as observed by HILL and DANSKY (1954), GROVER *et al.* (1972), FARRELL *et al.* (1973) and ISHIBASHI (1990). In the present study, however, the feed intake was not affected by dietary ME levels. The great amount of wheat bran was used in the low ME diet. The

Table 7. Performance of male and female Hinai-dori fed diets with 3 ME levels and 5 amino acid levels during period from 77 to 91 days of age[1]

| Diet No. | ME level (kcal/kg) | Ratio to standard(%)[2] | Body weight gain (g) | | Feed intake (g) | | Feed efficiency (gain : feed) | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Male | Female | Male | Female |
| 1 | 2,700 | 69 | 126.8[c] | 127.5[c] | 1241.5[b] | 1146.9 | .102[c] | .110[c] |
| 2 | 2,700 | 79 | 183.9[bc] | 220.3[b] | 1480.7[ab] | 1235.3 | .124[bc] | .175[b] |
| 3 | 2,700 | 89 | 184.0[bc] | 229.8[b] | 1348.4[ab] | 1424.9 | .131[bc] | .161[b] |
| 4 | 2,700 | 99 | 316.1[a] | 259.9[a] | 1538.2[ab] | 1296.5 | .206[a] | .201[a] |
| 5 | 2,700 | 109 | 292.9[ab] | 216.7[ab] | 1570.3[a] | 1200.9 | .185[ab] | .179[b] |
| | Pooled SE | | 24.0 | 16.4 | 48.0 | 41.7 | .013 | .011 |
| 6 | 2,900 | 72 | 131.6[c] | 185.2[b] | 1290.0[b] | 1370.3 | .102[c] | .135 |
| 7 | 2,900 | 82 | 279.7[b] | 189.4[b] | 1526.6[a] | 1220.2 | .183[b] | .155 |
| 8 | 2,900 | 92 | 280.5[b] | 196.6[ab] | 1487.2[ab] | 1177.0 | .189[b] | .168 |
| 9 | 2,900 | 102 | 306.2[a] | 181.6[b] | 1420.0[ab] | 1170.7 | .216[a] | .157 |
| 10 | 2,900 | 112 | 307.0[a] | 219.6[a] | 1405.2[ab] | 1246.1 | .218[a] | .176 |
| | Pooled SE | | 19.8 | 7.0 | 31.7 | 33.6 | .013 | .006 |
| 11 | 3,100 | 75 | 139.1[c] | 152.6[b] | 1377.3 | 1034.7[ab] | .098[c] | .146[b] |
| 12 | 3,100 | 85 | 270.3[b] | 222.2[ab] | 1461.1 | 1169.4[b] | .187[b] | .192[a] |
| 13 | 3,100 | 95 | 272.2[b] | 234.2[a] | 1457.9 | 1166.9[b] | .187[b] | .201[a] |
| 14 | 3,100 | 105 | 317.3[a] | 185.8[ab] | 1356.6 | 1053.0[ab] | .234[a] | .178[ab] |
| 15 | 3,100 | 115 | 295.0[ab] | 179.5[ab] | 1479.7 | 971.2[a] | .200[ab] | .183[ab] |
| | Pooled SE | | 19.3 | 11.6 | 35.3 | 28.5 | .014 | .009 |

[a-c, 1, 2] See footnotes in Table 5.

palatability of wheat bran was so bad for some Hinai-dori that feed intake might decrease on the high wheat bran diet. JACKSON *et al.* (1982) investigated the effect of dietary ME levels on the carcass composition of broiler chicks, and concluded that the carcass fat content increased with increasing dietary ME levels. Their result agreed well with the reports by FRAPS (1943) and HILL and Dansky (1954). Since the low fat meat was desirable for Hinai-dori, the high ME diet was undesirable. Therefore, the middle ME level used in this experiment, ranging 2,900 to 2,960 kcal ME/kg of diet, might be adequate in practice.

The body weight gain of Hinai-dori was slower than that of broiler. FUJIMURA *et al.* (1991) have proved that the contents of carcass protein, composition of amino acid in the meat and dietary amino acid digestibility by Hinai-dori were similar to those of broiler. Since the feed efficiency of broiler was superior to that of Hinai-dori, the ratio of protein synthesis of Hinai-dori might be slow than that of broiler or the ratio of protein degradation of Hinai-dori might be higher than that of broiler. It will be clarify in future.

Because only 4 dietary amino acids were adjusted to meet the temporary requirements in the present study, other amino acids might be contained more than the requirement levels. Since it is clear that the requirement of arginine is affected by the dietary lysine levels (JONES, 1964 and O'DELL and SAVAGE, 1966) and requirements of lysine and methionine are affected by the dietary CP levels (MORRIS *et al.*, 1987 ;

MENDONCA and JENSEN, 1989 ; MORRIS *et al.*, 1992), these excess amino acids might cause the negative effect on performance of Hinai-dori. The different breeds might have the different requirements of individual essential amino acids. Actually, the different amino acid requirements are recommended by feeding standards for broiler and layer-strain pullet. It is necessary to estimate the individual essential amino acid requirements for effective production of Hinai-dori.

This result was obtained from the small number of chicks. It will be necessary to confirm using large number of Hinai-dori.

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# 飼料のアミノ酸および代謝エネルギー水準が比内鶏の生産性におよぼす影響

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比内鶏の必須アミノ酸要求量を決定するのに先立って，飼料のアミノ酸および代謝エネルギー（ME）水準が比内鶏の生産性におよぼす影響を調べた。

試験1，2および3は，それぞれ7から21，42から56および77から91日齢の各14日間で行った。試験飼料は，ME水準を3，アミノ酸水準を5段階とする計15種類とし，各飼料に雌雄3羽ずつ割り当てた。鶏は単飼とし，飼料と水は自由摂取させた。各試験終了時に体重および飼料摂取量を記録した。

飼料のアミノ酸およびME水準に対する比内鶏の反応には性差が認められなかった。増体量および飼料効率はアミノ酸水準の増加にともなって向上したが，飼料摂取量は影響を受けなかった。増体量，飼料効率および飼料摂取量はME水準の影響を受けなかった。最大の増体量および飼料効率を示すアミノ酸水準は加齢とともに減少した。増体量は42から56日齢にかけて最大値を示した。

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