ABSTRACT A dose-response experiment with 6 dietary
methionine levels (0.20, 0.275, 0.35, 0.425, 0.50, and
0.575%) was conducted with male White Peking duck-
lings to estimate the methionine requirement of growing
ducks from 21 to 49 d of age. One-day-old male White
Peking ducklings were fed common starter diets from
hatching to 21 d of age and then fed the experimental
diets from 21 to 49 d of age. Three hundred thirty-six 21-
d-old birds were allotted to 24 pens with 14 birds per
pen according to similar pen weight. There were 6 dietary
treatments, each containing 4 replicate pens. At 49 d of
age, weight gain, feed intake, and feed/gain of ducks
from each pen were measured, and 2 ducks selected ran-
domly from each pen were slaughtered to evaluate the
yields of abdominal fat, breast meat (including pectoralis
major and pectoralis minor), and leg meat (including
thigh and drum stick). Significant effects of dietary methi-
onine on weight gain, breast meat, and abdominal fat
were observed. Both weight gain and breast meat yield
showed significant quadratic response to increasing di-
etary methionine, and abdominal fat decreased linearly
($P < 0.05$). According to the quadratic model, the optimal
methionine requirement of male White Peking ducks
from 21 to 49 d of age for maximum weight gain and
breast meat yield were 0.377 and 0.379%, respectively.

Key words: methionine, duck, requirement

INTRODUCTION

Methionine plays an important role in poultry growth,
and it is the first-limiting amino acid in common poultry
diets. Supplementation of methionine in the diet could
improve growth performance and carcass quality of
growing broiler chickens, and it was observed in many
studies (Jensen et al., 1989; Hickling et al., 1990; Moran,
Esteve-Garcia and Llauradó, 1997; Pestí et al., 1999; Wal-
lis, 1999; Yalcın et al., 1999; Esteve-Garcia and Mack, 2000;
Lemme et al., 2002; Vieira et al., 2004), but few were
reported in ducks. The methionine requirement of NRC
(1994) for growing White Peking ducks from 2 to 7 wk
of age is 0.3%, but this value is questionable because it is
taken from the research in Muscovy ducks (Leclercq
and de Carvile, 1977), and these ducks grow more slowly
than Peking ducks during this period (Swatland, 1980).
Recent studies showed that some amino acid require-
ments, such as lysine, valine, and methionine, of starter
or growing Peking ducks were higher than current NRC
(1994) recommendations (Bons et al., 2002; Timmler and
Rodehutscord, 2003; Xie et al., 2004), which indicated that

the amino acid requirement should be reevaluated to
adapt to modern duck genotype. The impacts of dietary
methionine on growth performance and carcass charac-
teristics of growing Peking ducks were reported by Luo
and Gao (2002) and Wang et al. (2004), but the require-
ment was not estimated accurately due to lack of a mathe-
atical model in their studies. Therefore, through the
dose-response relationship for methionine, the objective
of our study was to determine the methionine require-
ment of male White Peking ducks from 21 to 49 d of age
in terms of growth performance and carcass quality.

MATERIALS AND METHODS

Dose-response experiment with 6 dietary methionine
levels (0.20, 0.275, 0.35, 0.425, 0.50, and 0.575%) was con-
ducted with 21-d-old male White Peking ducklings. Four
hundred forty 1-d-old male White Peking ducklings from
one commercial hatchery were divided into 22 raised
wire-floor pens with 20 birds per pen, and they were
raised with common starter diet (Table 1) from hatching
to 21 d of age. During this period, water and feed were
provided ad libitum and lighting was continuous.
The temperature was kept at 33°C from 1 to 3 d of age, and
then it was reduced gradually to room temperature until
21 d of age.

At 21 d of age, all ducks were weighed individually,
and 336 birds selected from these ducks were allotted to
24 raised wire-floor pens with 14 birds per pen according
Table 1. Composition of common starter feed from hatching to 21 d of age and methionine-deficient basal diet from 21 to 49 d of age (% as fed)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Common starter feed (0 to 21 d)</th>
<th>Basal feed (21 to 49 d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>62</td>
<td>62.5</td>
</tr>
<tr>
<td>Corn starch</td>
<td>8.2</td>
<td></td>
</tr>
<tr>
<td>Soybean meal</td>
<td>34</td>
<td>10</td>
</tr>
<tr>
<td>Peanut meal</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>DL-Methionine</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>t-Lysine-HCl</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Limestone</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Vitamin and trace mineral premix 1</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Calciated composition</td>
<td>2.814.3</td>
<td>2.909.13</td>
</tr>
<tr>
<td>Crude protein</td>
<td>20.4</td>
<td>17.0</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.52</td>
<td>0.20</td>
</tr>
<tr>
<td>Cystine</td>
<td>0.26</td>
<td>0.31</td>
</tr>
<tr>
<td>Lysine</td>
<td>1.05</td>
<td>0.93</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.83</td>
<td>0.87</td>
</tr>
<tr>
<td>Available phosphorus</td>
<td>0.41</td>
<td>0.41</td>
</tr>
</tbody>
</table>

1Supplied per kilogram of total diet: Cu, 10 mg; Fe, 60 mg; Zn, 60 mg; Mn, 80 mg; Se, 0.3 mg; I, 0.2 mg; Cr, 0.15 mg; choline chloride, 1,000 mg; vitamin A (retinyl acetate), 10,000 IU; vitamin D3, 3,000 IU; vitamin E (dl-α-tocopherol acetate), 20 IU; vitamin K3, 2 mg; thiamine, 2 mg; riboflavin, 8 mg; pyridoxine, 4 mg; vitamin B12, 0.02 mg; pantothenic acid, 20 mg; nicotinic acid, 50 mg; folic acid, 1 mg; biotin, 0.2 mg. 
2Supplied per kilogram of total diet: Cu, 10 mg; Fe, 60 mg; Zn, 60 mg; Mn, 80 mg; Se, 0.3 mg; I, 0.2 mg; Cr, 0.15 mg; choline chloride, 750 mg; vitamin A (retinyl acetate), 8,000 IU; vitamin D3, 3,000 IU; vitamin E (dl-α-tocopherol acetate), 20 IU; vitamin K3, 2 mg; thiamine, 1.5 mg; riboflavin, 8 mg; pyridoxine, 3 mg; vitamin B12, 0.02 mg; pantothenic acid, 10 mg; nicotinic acid, 50 mg; folic acid, 1 mg; biotin, 0.2 mg. 
3The values are calculated according to the AME of chickens. 
4The numbers are analyzed values.

RESULTS AND DISCUSSION

In our study, supplementation of methionine in the diet affected weight gain significantly but not feed intake and feed/gain (Table 2). Weight gain increased and then decreased as dietary methionine increased, and this response provided a significant fit to a quadratic model \(Y\) (daily weight gain) = 53.48 + 78.55\(X\) (dietary methionine) - 99.05\(X^2\); \(R^2 = 0.9157, CV = 0.90\). According to this model, the methionine requirement for obtaining maximum weight gain of growing ducks from 21 to 49 d of age was 0.377% (95% of dietary methionine level at maximum weight gain). When dietary cystine level (0.31%) was considered in our study, the total sulfur amino acid requirement of these ducks during this period was 0.687%, and cystine supplied 45% of it. The cystine replacement value estimated by us was in agreement with that of NRC (1994; 45%), and it was higher than the value (38 to 43%) of growing broilers reported by Wheeler and Latshaw (1981), but it intervened between the 2 values for slow-feeding growing broilers (44%) and fast-feeding growing broilers (47%) reported by Kalinowski et al. (2003).

Wang et al. (2004) found that the body weight of 41-d-old White Peking ducks was increased significantly when 0.12% DL-methionine was supplemented to the basal diet containing 0.3% methionine. Luo and Gao (2002) estimated the requirement of White Peking ducks from 14 to 35 d of age through dose-response experiment and recommended 0.35% dietary methionine for these ducks during this period. However, due to the lack of a mathematical model in aforementioned studies, the methionine requirement obtained from them was questionable. The NRC (1994) recommended 0.30% dietary methionine for growing White Peking ducks from 2 to 7 wk of age, but this value was taken from the research in Muscovy ducks (Leclerq and de Carvile, 1977) and these ducks grow more slowly than Peking ducks. Because dietary protein level could affect the sulfur amino acid requirement of growing broilers (Mendonca and Jensen, 1989; Morris et al., 1992; Huyghebaert et al., 1994; Huyghebaert and Pack, 1996; Vieira et al., 2004), the ratio of methionine to CP was used to compare the difference between our result and others. According to this ratio, the methionine requirement estimated by us was higher than those reported by NRC (1994) and Luo and Gao (2002; 0.0222 vs. 0.0188, 0.0222 vs. 0.0196) but was similar to the dietary methionine level used by Wang et al. (2004; 0.0222 vs. 0.0221).

Methionine supplementation affected breast meat yield and abdominal fat deposition of growing ducks significantly but not leg meat yield in our study (Table 3). Breast meat was the most valuable part of carcass when birds were further processed. The results of many studies have led to the assumption that breast meat yield of broilers is improved when methionine is supplemented in the
Table 2. Effect of dietary methionine on weight gain, feed intake, and feed/gain of male Peking ducks from 21 to 49 d of age 1

<table>
<thead>
<tr>
<th>Met (%)</th>
<th>Daily weight gain (g/bird per day)</th>
<th>Daily feed intake (g/bird per day)</th>
<th>Feed/gain (g/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.20</td>
<td>64.93 b</td>
<td>212.19</td>
<td>3.27</td>
</tr>
<tr>
<td>0.275</td>
<td>67.98 ab</td>
<td>208.67</td>
<td>3.08</td>
</tr>
<tr>
<td>0.35</td>
<td>69.02</td>
<td>219.72</td>
<td>3.19</td>
</tr>
<tr>
<td>0.425</td>
<td>69.06 a</td>
<td>213.76</td>
<td>3.10</td>
</tr>
<tr>
<td>0.50</td>
<td>67.20 ab</td>
<td>204.28</td>
<td>3.04</td>
</tr>
<tr>
<td>0.575</td>
<td>66.33 ab</td>
<td>206.07</td>
<td>3.11</td>
</tr>
<tr>
<td>SEM</td>
<td>0.44</td>
<td>1.85</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Probability
Met 0.0391 0.1319 0.2902
Met linear 0.7682 0.3465 0.1671
Met quadratic 0.0245 0.4062 0.3061

*Means with different superscripts within the same column differ significantly (P < 0.05).
1Results are means with n = 4 per treatment.

Table 3. Effect of dietary methionine on breast meat, leg meat, and abdominal fat of 49-day-old male Peking ducks 1

<table>
<thead>
<tr>
<th>Met (%)</th>
<th>Leg meat</th>
<th>Breast meat</th>
<th>Abdominal fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.20</td>
<td>8.22</td>
<td>8.89b</td>
<td>1.85a</td>
</tr>
<tr>
<td>0.275</td>
<td>8.23</td>
<td>9.72bc</td>
<td>1.62b</td>
</tr>
<tr>
<td>0.35</td>
<td>8.17</td>
<td>10.15a</td>
<td>1.70b</td>
</tr>
<tr>
<td>0.425</td>
<td>8.68</td>
<td>9.91ab</td>
<td>1.49c</td>
</tr>
<tr>
<td>0.50</td>
<td>8.01</td>
<td>9.58bc</td>
<td>1.48c</td>
</tr>
<tr>
<td>0.575</td>
<td>8.50</td>
<td>9.09bc</td>
<td>1.47c</td>
</tr>
<tr>
<td>SEM</td>
<td>0.12</td>
<td>0.14</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Probability
Met 0.4971 0.0168 0.0219
Met linear 0.5989 0.7252 0.0185
Met quadratic 0.8892 0.0413 0.0625

*Means with different superscripts within the same column differ significantly (P < 0.05).
1Results are means with n = 4 per treatment.

However, compared with the report of Schutte and Pack (1995) in which total sulfur amino acid requirement of broilers for obtaining maximum breast meat yield was about 5.95% higher than for obtaining maximum weight gain, this difference in our study was too small to have any practical significance.

Methionine supplementation could decrease abdominal fat deposition in broilers and it was observed in many studies (Jensen et al., 1989; Moran, 1994; Schutte and Pack, 1995; Wallis, 1999; McDevitt et al., 2000; Vieira et al., 2004). In our study, supplementation of methionine in the basal diet could significantly lowered abdominal fat yield and showed significant linear response to increasing dietary methionine \( Y(abdominal fat yield) = 1.98 - 0.96X(dietary methionine); R^2 = 0.7864, CV = 4.92 \) (Table 3). This finding was in agreement with aforementioned reports in broilers, and Takahashi and Akiba (1995) found that this might be related to the effects of methionine on key enzymes in lipogenesis and lipolysis.

In conclusion, optimal supplementation of methionine in diets could increase breast meat yield and decrease abdominal fat deposition in growing Peking ducks. The
optimal methionine requirement of male Peking ducks from 21 to 49 d of age for maximum weight gain and breast meat yield were 0.377 and 0.379%, respectively.

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