Research Notes

Evaluation of Valine Requirement of the Commercial Layer using a Corn-Soybean Meal Basal Diet

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ABSTRACT

An experiment was conducted with Hy-Line W-36® hens to evaluate the Val requirement in a corn-soybean meal diet. Eight experimental diets were fed with Val levels of 0.700, 0.665, 0.630, 0.595, 0.560, and 0.525%. A positive control (0.765% Val) was fed. Egg production (EP) was increased by addition of Val to 0.630%. Egg weight (EW) was increased by addition of Val to 0.655%. Broken-line regression indicated a daily Val requirement of 592.5, 677.7, and 619.0 mg/hen per d for EP, EW, and egg contents (EC), respectively. This requirement was 13.1 mg/g of EC.

(Key words: commercial layers, valine, egg production, egg weight)

INTRODUCTION

In 1971, the National Research Council (NRC, 1971) did not give a recommendation for the Val requirement of the commercial laying hen. In 1977 they (NRC, 1977) estimated the requirement to be 550 mg/hen per d and later increased it to 600 mg/hen per day (NRC, 1984). They (NRC, 1994) have estimated the Val requirement to be 700 mg/hen per d in their latest suggestion. These estimates were often changed because limited research data were available on the Val requirement.

Johnson and Fisher (1959) suggested a requirement of 0.54% Val for the commercial layer. The level of production of their hens was low when these suggestions were made. Hurwitz and Bornstein (1978) suggested a daily Val requirement of 820 mg/hen per d for Leghorn × Rhode Island Red hens weighing approximately 2,000 g; however, this level was the least fed (0.673%), and the hens consumed 122 g of feed, which resulted in an intake of 821 mg/hen per d. Therefore, their requirement was only a suggestion.

Harms and Ivey (1993) reported an improvement in performance of commercial layers by adding Val to a corn-soybean meal diet containing supplemental Met, Lys, Trp, Arg, and Thr. These hens had a daily intake of 619 mg of Val. The hens receiving the diet without supplemental Val from 31 to 34 wk had a daily intake of 537 mg Val. Egg production (EP) was 81.13% with 55.7 g egg weight (EW), which resulted in an egg content (EC) of 40.91 g and an intake of 12.9 mg/g EC (52.8/40.91). If the hens were producing 50 g of EC, the calculated daily requirement would be 645 mg.

Schutte (1998) recommended a daily intake of 600 mg available Val, or a 720 mg intake of total Val. Coon and Zhang (1999) suggested a daily requirement of 680 mg of digestible Val for the commercial Leghorn-type layer. They further suggested a requirement of 13.2 mg of digestible Val/g of egg mass.

It is apparent that sufficient data are not available to establish a reliable estimate of the Val requirement of the laying hen. Therefore, the present experiment was conducted to evaluate the Val requirement in a corn-soybean diet.

MATERIALS AND METHODS

Hy-Line W-36® hens, 39 wk of age, were used in this experiment. They were housed one bird per cage in a windowless, fan-ventilated house. The temperature of the house was not allowed to fall below 26.7 C and was almost constant because the experiment was conducted in March and April. The temperature was controlled to get a feed intake low enough to produce a Val deficiency. They were given 16 h of artificial light per day.

Eight experimental diets were fed (Table 1). Diet 1 was a positive control diet containing 0.765% Val to support maximum performance. Diet 2 contained 0.700% Val and other supplemental acids that previously had been shown to support maximum perfor-

Abbreviation Key: AA = amino acids; EC = egg content; EP = egg production; EW = egg weight.
TABLE 1. Composition of diets (%)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Diet 1</th>
<th>Diet 2</th>
<th>Diet 3</th>
<th>Diet 4</th>
<th>Diet 5</th>
<th>Diet 6</th>
<th>Diet 7</th>
<th>Diet 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valine content</td>
<td>0.765</td>
<td>0.700</td>
<td>0.665</td>
<td>0.630</td>
<td>0.595</td>
<td>0.560</td>
<td>0.525</td>
<td>0.630</td>
</tr>
<tr>
<td>Yellow corn</td>
<td>66.627</td>
<td>69.844</td>
<td>71.484</td>
<td>73.260</td>
<td>75.061</td>
<td>76.850</td>
<td>78.650</td>
<td>73.113</td>
</tr>
<tr>
<td>Limestone</td>
<td>7.667</td>
<td>7.652</td>
<td>7.643</td>
<td>7.635</td>
<td>7.627</td>
<td>7.626</td>
<td>7.612</td>
<td>7.634</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>1.175</td>
<td>1.240</td>
<td>1.276</td>
<td>1.310</td>
<td>1.344</td>
<td>1.378</td>
<td>1.412</td>
<td>1.312</td>
</tr>
<tr>
<td>Vitamin mix</td>
<td>0.250</td>
<td>0.250</td>
<td>0.250</td>
<td>0.250</td>
<td>0.250</td>
<td>0.250</td>
<td>0.250</td>
<td>0.250</td>
</tr>
<tr>
<td>Mineral mix</td>
<td>0.250</td>
<td>0.250</td>
<td>0.250</td>
<td>0.250</td>
<td>0.250</td>
<td>0.250</td>
<td>0.250</td>
<td>0.250</td>
</tr>
<tr>
<td>Salt</td>
<td>0.378</td>
<td>0.378</td>
<td>0.378</td>
<td>0.378</td>
<td>0.378</td>
<td>0.378</td>
<td>0.378</td>
<td>0.378</td>
</tr>
<tr>
<td>DL Met</td>
<td>0.107</td>
<td>0.101</td>
<td>0.109</td>
<td>0.100</td>
<td>0.095</td>
<td>0.083</td>
<td>0.073</td>
<td>0.118</td>
</tr>
<tr>
<td>Trp</td>
<td>—</td>
<td>0.001</td>
<td>0.012</td>
<td>0.014</td>
<td>0.015</td>
<td>0.017</td>
<td>0.018</td>
<td>0.024</td>
</tr>
<tr>
<td>Lys-HCl</td>
<td>—</td>
<td>0.114</td>
<td>0.175</td>
<td>0.198</td>
<td>0.196</td>
<td>0.206</td>
<td>0.217</td>
<td>0.236</td>
</tr>
<tr>
<td>Thr</td>
<td>—</td>
<td>0.008</td>
<td>0.029</td>
<td>0.031</td>
<td>0.030</td>
<td>0.031</td>
<td>0.031</td>
<td>0.037</td>
</tr>
<tr>
<td>Ile</td>
<td>—</td>
<td>0.005</td>
<td>0.040</td>
<td>0.045</td>
<td>0.051</td>
<td>0.055</td>
<td>0.059</td>
<td>0.075</td>
</tr>
</tbody>
</table>

Calculated analysis %

- Protein: 15.86, 14.66, 14.06, 13.37, 12.66, 11.96, 11.26, 13.46
- Met: 0.360, 0.340, 0.340, 0.323, 0.310, 0.290, 0.270, 0.340
- Lys: 0.820, 0.820, 0.820, 0.790, 0.740, 0.700, 0.660, 0.820
- Trp: 0.200, 0.180, 0.180, 0.170, 0.160, 0.150, 0.140, 0.180
- Thr: 0.583, 0.540, 0.534, 0.507, 0.481, 0.454, 0.427, 0.534
- Arg: 1.022, 0.920, 0.856, 0.810, 0.755, 0.700, 0.645, 0.810
- Ile: 0.071, 0.077, 0.073, 0.071, 0.064, 0.059, 0.054, 0.071

Energy, kcal/kg: 2,811, 2,840, 2,857, 2,873, 2,889, 2,905, 2,921, 2,874

1Contains 18.5% P and 21% Ca.
2Supplies per kilogram of diet: biotin, 2.84 mg; cholecalciferol, 3,124 IU; choline, 710 mg; ethoxyquin, 92 mg; folic acid, 1.4 mg; niacin, 85 mg; pantothenic acid, 21 mg; pyridoxine, 7 mg; riboflavin, 7 mg; thiamin, 4 mg; vitamin A, 11,360 IU; vitamin B12, 0.03 mg; vitamin E, 28 IU; vitamin K3, 3 mg.
3Supplies per kilogram of diet: copper, 14 mg; ethoxyquin, 92 mg; iodine, 3 mg; iron, 60 mg; manganese, 128 mg; selenium, 0.3 mg; zinc, 114 mg.
4Based on analysis of corn and soybean meal.
5Same Val level as Diet 4 with higher levels of other AA.

Diet 3 contained 0.655% Val (95% of Diet 2), and the other amino acids (AA) were at the level in Diet 2. Diet 4 contained 0.630% (90% of Diet 2) Val and the other AA were included at 95% that in Diet 2. Diet 5 contained 0.595% Val (85% of Diet 2), and the levels of the AA were held at a 95% level of Diet 4. Diet 6 contained 0.560% Val and 100% of the other AA in Diet 5. Diet 7 contained 0.525% Val (75% of the Val in Diet 2 and 95% of the other AA in Diet 6). Diet 8 contained 0.630% Val and 100% of the other AA in Diet 2. Diet 8 was to ensure that Val was the first-limiting AA in Diet 4, because it contained higher levels of other AA than did Diet 4. Eight replicates of five hens were fed each diet. The diets were not isocaloric, because analyses of data were based on the daily intake of Val.

Egg production was recorded for individual hens but was analyzed on a replicate basis. Feed consumption was measured biweekly, and that left over was replaced with feed from a new mix at that time. From each hen, one egg that was laid on the last 2 d of each week was weighed. The eggs were broken out, and the shells were washed, allowed to dry, and weighed. Egg content was calculated as EP × EW – shell weight. Hens were individually weighted at the beginning and end of the experiment, and weight gain was calculated. The daily intake of Val was calculated as the amount of Val in the feed.

TABLE 2. Performance of commercial layers fed various levels of Val

<table>
<thead>
<tr>
<th>Dietary Val (%)</th>
<th>Egg production (%)</th>
<th>Egg weight (g)</th>
<th>Egg content (EC) (g)</th>
<th>Feed consumption (g/h/d)</th>
<th>Val intake</th>
<th>Weight gain (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.765</td>
<td>87.4a</td>
<td>59.5a</td>
<td>47.3a</td>
<td>94.3a</td>
<td>722a</td>
<td>111a</td>
</tr>
<tr>
<td>0.700</td>
<td>86.7a</td>
<td>59.6a</td>
<td>47.1a</td>
<td>96.2a</td>
<td>674a</td>
<td>124a</td>
</tr>
<tr>
<td>0.665</td>
<td>87.2a</td>
<td>59.3b</td>
<td>47.1a</td>
<td>94.3a</td>
<td>627a</td>
<td>79a</td>
</tr>
<tr>
<td>0.630</td>
<td>87.2a</td>
<td>57.5d</td>
<td>45.7b</td>
<td>93.1a</td>
<td>586a</td>
<td>118a</td>
</tr>
<tr>
<td>0.595</td>
<td>84.2a</td>
<td>57.2c</td>
<td>44.3c</td>
<td>91.7a</td>
<td>546a</td>
<td>109a</td>
</tr>
<tr>
<td>0.560</td>
<td>83.7a</td>
<td>57.2d</td>
<td>43.6e</td>
<td>91.0a</td>
<td>509f</td>
<td>84a</td>
</tr>
<tr>
<td>0.525</td>
<td>77.9b</td>
<td>56.3d</td>
<td>40.1d</td>
<td>81.2b</td>
<td>426c</td>
<td>–30b</td>
</tr>
<tr>
<td>0.630</td>
<td>85.4a</td>
<td>58.2bc</td>
<td>45.3bc</td>
<td>91.8a</td>
<td>579d</td>
<td>102a</td>
</tr>
</tbody>
</table>

Means within a column with no common superscript differ significantly (P ≤ 0.05).

Diet 8 contained higher levels of amino acids than the other diet with 0.630% Val (Diet 4).
FIGURE 1. Broken-line regression of egg production, egg weight, and egg content on Val intake. EGG PROD = egg production.

RESULTS AND DISCUSSION

Egg production was not affected when hens received the diet with 0.630% Val (Table 2); however, EP was reduced each time Val was reduced below 0.630%. Broken-line regression indicated the requirement was 592.5 ± 19.9 mg/hen per d (Figure 1). However, 0.665% Val was necessary to support maximum EW (Table 2). Broken-line regression indicated the requirement for EW was 677.7 ± 40.0 mg/hen per d (Figure 1).

Broken-line regression indicated a Val requirement of 619.0 ± 14.6 mg/hen per d for EC (Figure 1). This result indicates that a hen needs 13.1 mg Val/g EC. Although feed consumption appeared to decline when the hens received the diet with 0.595% Val (Table 2), a significant reduction occurred when the diet contained 0.525% Val. The daily intake of Val decreased as the percentage of Val in the diet decreased. This decrease resulted in lower EC. Weight gain was significantly reduced when the level of Val was reduced to 0.525% (Table 2).

Egg production, EW, and EC were not significantly different for the two diets containing 0.630% Val (Diets 4 and 8). Diet 8 contained 5% more supplemental AA other than Val in Diet 4, indicating that Val was the first-limiting AA in Diet 4. Therefore, the basal diet used in this experiment was adequate to assay the requirement for Val.

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REFERENCES


