Live and Processing Performance Responses of Broilers Fed Low and Extra-Low Nutrient Density Withdrawal Diets Supplemented with Virginiamycin

H. M. Cervantes,*1 K. W. Bafundo,* G. M. Pesti,† and R. I. Bakalli†

*Phibro Animal Health, Ridgefield Park, NJ 07660; and †Poultry Science Department, University of Georgia, Athens 30602

Primary Audience: Nutritionists, Complex Managers, Veterinarians

SUMMARY

Two experiments were conducted to demonstrate the nutrient-sparing effects and cost-effectiveness of virginiamycin (VM) when fed to broiler chickens in extended withdrawal diets. In experiment 1, broiler chickens (Ross × Cobb) were fed the same starter and grower diets. On d 30, the chickens were switched to the withdrawal diets, and these were fed until 49 d when the experiment ended. Treatments were as follows: 1) standard broiler withdrawal diet (17.1% CP), 2) a broiler withdrawal diet with low nutrient density (16% CP), and 3) the same broiler withdrawal diet as treatment 2 but supplemented with 15 ppm VM. In experiment 2, broiler chickens (Ross × Cobb) were fed the same starter and grower diets to d 35 when they were switched to the withdrawal diets, and these were fed until the experiment ended (d 49). Birds on treatment 1 received a standard broiler withdrawal diet similar to the one used in experiment 1, birds on treatment 2 received a broiler withdrawal diet with extra-low nutrient density (15% CP), and birds on treatment 3 received the same broiler withdrawal diet as in treatment 2 but supplemented with 15 ppm VM. In both experiments, the chickens fed the withdrawal diet containing VM had the heaviest BW, and the unadjusted feed conversions were comparable for the standard withdrawal diet (without reduced nutrient density) and the reduced nutrient density diets with VM. In both experiments, the chickens fed the withdrawal diets with VM had the lowest mortality. An analysis of the breast meat yield results showed that in both experiments, the birds fed the extended withdrawal diets with VM produced more total pounds of breast meat than the other 2 treatments.

Key words: broiler, virginiamycin, nutrient density, withdrawal diet

DESCRIPTION OF PROBLEM

Several studies [1–10] have shown that in addition to being effective for the prevention of necrotic enteritis [11, 12], the antibiotic feed additive virginiamycin (VM, Stafac) spares nutrients essential for optimal poultry flock performance. The nutrient-sparing effect of VM has

1Corresponding author: Hector.Cervantes@pahc.com
been attributed to a reduction in nutrient breakdown by the intestinal microflora of the bird, a decrease in intestinal mass, and a slower rate of passage of digesta [13–15].

In recent years, the adoption of least-cost formulation philosophies has resulted in severe scrutiny of diet cost. This in turn has resulted in some integrators opting not to take advantage of antibiotic feed additives like VM. Although low diet cost may be maintained, the integrator misses an opportunity to maximize returns. Others [16, 17] have cautioned about the risks of focusing on lowest feed cost instead of maximum returns.

The objective of the studies reported in this paper was to determine whether the additional diet cost incurred by the use of VM could be offset by the savings on nutrient-sparing and the improvements on live and processed bird performance.

MATERIALS AND METHODS

Experiment 1

This experiment was started on May 6, 2003 and ended on June 26, 2003. The experiment was conducted in a research house at the University of Georgia Poultry Research Center in Athens. One thousand two hundred thirty Ross × Cobb [18] 1-d-old chicks were randomly allocated into 30 pens each containing 41 birds. Three treatments replicated 10 times were used in this experiment. At 1 d of age, 12 randomly chosen chicks were individually identified with neck and wing tags for processing evaluation at the end of the experiment. From 0 to 17 d, the birds on all treatments were fed a crumbled starter diet containing 21.6% CP and 1,391 kcal of ME/lb; the only feed additives included in the starter diet were salinomycin at 50 ppm and Roxarsone at 22.7 ppm. From 17 to 30 d, the birds on all treatments were fed a pelleted grower diet containing 19.6% CP and 1,429 kcal of ME/lb; the only feed additives included in the grower diet were salinomycin at 50 ppm and Roxarsone at 22.7 ppm. From 30 to 49 d, the birds were fed the experimental withdrawal diets (Table 1). The birds on treatment 1 were fed the standard withdrawal diet (STD), the birds on treatment 2 were fed the low nutrient density withdrawal diet (LND), and the birds on treatment 3 were fed the low nutrient density withdrawal diet plus 15 ppm VM (LND+). Based on ingredient prices taken from Feedstuffs (November 3, 2003), the estimated feed cost savings per 2,000 lb of feed when comparing the diets for treatment 1 vs. 2 were $7.93.

Chicks and feed were weighed by pen on d 0, 17, 30, and 49 to calculate average weight gain and feed conversions. The feed conversions were not adjusted for mortality, because this practice is not performed under commercial conditions. After the final weighing on d 49, the tagged birds from each pen were caught for final selection, and the 4 males and 4 females with the lowest tag numbers from each pen were placed back in their corresponding pen and maintained on their treatment diets. The feed was removed from 1 block of birds each at 2130, 2200, 2230, and 2300 h for slaughter at approximately 0930, 1000, 1030, and 1100 h the next day. One group of tagged birds from each treatment (24 birds) was processed at 1 time, individual live weight and sex of each bird were recorded immediately before slaughter, and the eviscerated carcasses were placed in a chill tank (ice water) and allowed to chill for 4 h; after the 4 h of chilling, each carcass was allowed to drain for 5 min, and each was then individually bagged and stored in a cooler overnight (at 4°C). The next day, the carcasses were removed from the cooler in groups of 24 in the same order in which they were processed the previous day for weighing and deboning. The weight of each chilled carcass was recorded immediately before deboning. The breast meat from each carcass was carefully removed, weighed, and individually recorded.

For statistical analysis, a completely randomized block design was used with 3 treatments and 10 replicates. The pen mean was the experimental unit. Data were subjected to ANOVA using the GLM procedures of SAS [19]. Nonsignificant terms (P > 0.10) were removed from the statistical models. Means were separated using Duncan’s new multiple-range test at the 5% level of probability.

Experiment 2

Everything in this experiment was identical to experiment 1 with the following exceptions: the experiment was started on August 19, 2003,
### Table 1. Ingredient composition and nutrient profile of experimental withdrawal diets (experiments 1 and 2)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Starter (experiments 1 and 2)</th>
<th>Grower (experiments 1 and 2)</th>
<th>Control (experiments 1 and 2)</th>
<th>Low density (experiment 1)</th>
<th>Extra-low density (experiment 2)</th>
<th>Extra-low density +Stafac&lt;sup&gt;1&lt;/sup&gt; (experiment 2)</th>
<th>Extra-low density +Stafac&lt;sup&gt;2&lt;/sup&gt; (experiment 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn, grain</td>
<td>62.796</td>
<td>67.471</td>
<td>64.727</td>
<td>67.929</td>
<td>79.521</td>
<td>80.894</td>
<td>80.938</td>
</tr>
<tr>
<td>Soybean meal - 48%</td>
<td>30.143</td>
<td>25.08</td>
<td>18.9</td>
<td>15.562</td>
<td>15.583</td>
<td>12.962</td>
<td>12.997</td>
</tr>
<tr>
<td>Poultry fat</td>
<td>1.848</td>
<td>2.449</td>
<td>2.472</td>
<td>0.514</td>
<td>0.553</td>
<td>0.500</td>
<td>0.500</td>
</tr>
<tr>
<td>Menhaden meal</td>
<td>2.000</td>
<td>2.000</td>
<td>2.000</td>
<td>2.000</td>
<td>2.000</td>
<td>2.000</td>
<td>2.000</td>
</tr>
<tr>
<td>Limestone</td>
<td>0.692</td>
<td>0.615</td>
<td>0.634</td>
<td>0.614</td>
<td>0.614</td>
<td>1.469</td>
<td>1.34</td>
</tr>
<tr>
<td>Difluorinated phosphate</td>
<td>1.374</td>
<td>1.193</td>
<td>0.905</td>
<td>0.641</td>
<td>0.642</td>
<td>0.714</td>
<td>0.713</td>
</tr>
<tr>
<td>Common salt</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.539</td>
<td>0.540</td>
</tr>
<tr>
<td>Vitamin premix&lt;sup&gt;3&lt;/sup&gt;</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.400</td>
<td>0.400</td>
</tr>
<tr>
<td>Mineral premix&lt;sup&gt;4&lt;/sup&gt;</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
<td>0.250</td>
<td>0.250</td>
</tr>
<tr>
<td>ox- Met</td>
<td>0.253</td>
<td>0.247</td>
<td>0.177</td>
<td>0.153</td>
<td>0.153</td>
<td>0.080</td>
<td>0.080</td>
</tr>
<tr>
<td>L-Lys HCl</td>
<td>0.105</td>
<td>0.155</td>
<td>0.109</td>
<td>0.155</td>
<td>0.155</td>
<td>0.086</td>
<td>0.086</td>
</tr>
<tr>
<td>Salinomycin</td>
<td>0.046</td>
<td>0.046</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.107</td>
<td>0.106</td>
</tr>
<tr>
<td>Roxarsone</td>
<td>0.013</td>
<td>0.013</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Virginiamycin</td>
<td>0</td>
<td>0</td>
<td>0.0375</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Composition, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME&lt;sub&gt;i&lt;/sub&gt;, kcal/lb</td>
<td>1,391</td>
<td>1,429</td>
<td>1,460</td>
<td>1,435</td>
<td>1,435</td>
<td>1,435</td>
<td>1,435</td>
</tr>
<tr>
<td>Protein</td>
<td>21.6</td>
<td>19.6</td>
<td>17.1</td>
<td>16</td>
<td>16</td>
<td>15.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Ca</td>
<td>0.9</td>
<td>0.8</td>
<td>0.7</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Total P</td>
<td>0.668</td>
<td>0.617</td>
<td>0.545</td>
<td>0.492</td>
<td>0.492</td>
<td>0.475</td>
<td>0.474</td>
</tr>
<tr>
<td>Available P</td>
<td>0.44</td>
<td>0.4</td>
<td>0.34</td>
<td>0.29</td>
<td>0.29</td>
<td>0.270</td>
<td>0.270</td>
</tr>
<tr>
<td>Arg</td>
<td>1.363</td>
<td>1.205</td>
<td>1.015</td>
<td>0.92</td>
<td>0.92</td>
<td>0.851</td>
<td>0.851</td>
</tr>
<tr>
<td>Leu</td>
<td>1.845</td>
<td>1.703</td>
<td>1.538</td>
<td>1.468</td>
<td>1.468</td>
<td>1.399</td>
<td>1.400</td>
</tr>
<tr>
<td>Lys</td>
<td>1.23</td>
<td>1.13</td>
<td>0.93</td>
<td>0.88</td>
<td>0.88</td>
<td>0.780</td>
<td>0.780</td>
</tr>
<tr>
<td>Met</td>
<td>0.599</td>
<td>0.567</td>
<td>0.469</td>
<td>0.433</td>
<td>0.433</td>
<td>0.355</td>
<td>0.355</td>
</tr>
<tr>
<td>Cys</td>
<td>0.341</td>
<td>0.313</td>
<td>0.281</td>
<td>0.267</td>
<td>0.267</td>
<td>0.255</td>
<td>0.255</td>
</tr>
<tr>
<td>TSAA&lt;sup&gt;6&lt;/sup&gt;</td>
<td>0.94</td>
<td>0.88</td>
<td>0.75</td>
<td>0.7</td>
<td>0.7</td>
<td>0.610</td>
<td>0.610</td>
</tr>
<tr>
<td>Thr</td>
<td>0.796</td>
<td>0.715</td>
<td>0.618</td>
<td>0.572</td>
<td>0.572</td>
<td>0.534</td>
<td>0.534</td>
</tr>
<tr>
<td>Trp</td>
<td>0.274</td>
<td>0.24</td>
<td>0.198</td>
<td>0.177</td>
<td>0.177</td>
<td>0.161</td>
<td>0.161</td>
</tr>
<tr>
<td>Val</td>
<td>0.985</td>
<td>0.891</td>
<td>0.78</td>
<td>0.729</td>
<td>0.729</td>
<td>0.686</td>
<td>0.686</td>
</tr>
</tbody>
</table>

<sup>1</sup>Low-density withdrawal diet plus 15 ppm Stafac (virginiamycin).

<sup>2</sup>Extra-low density withdrawal diet plus 15 ppm Stafac (virginiamycin).

<sup>3</sup>Vitamin premix provides the following per kilogram of diet: vitamin A, 5,500 IU from all trans-retinyl acetate; cholecalciferol, 1,100 IU; vitamin E, 11 IU from all-α-tocopherol acetate; riboflavin, 4.4 mg; Ca pantothenate, 12 mg; niacin acid, 44 mg; choline Cl, 220 mg; vitamin B<sub>12</sub>, (cobalamin) 12.0 μg; pyridoxine-HCl, 2.7 mg; menadione sodium bisulfit complex, 3.34 mg; folic acid, 0.55 mg; D-biotin, 0.11 mg; thiamine, 2.4 mg (as thiamine mononitrate); and ethoxyquin, 150 mg.

<sup>4</sup>Trace mineral premix provides the following in milligrams per kilogram of diet: manganese (MnSO₄·H₂O), 60; zinc (ZnO), 50; iron (FeSO₄·7H₂O), 30; copper (CuSO₄·5H₂O), 5; iodine (ethylene diamine dihydroiodide), 1.5; and selenium (Na₂SeO₃), 0.3.

<sup>5</sup>From ingredient composition tables [20].

<sup>6</sup>Methionine and Cys.
Table 2. Influence of nutrient levels with and without virginiamycin (VM) in extended withdrawal feeds on BW, feed consumption, FCR, and mortality (0 to 49 d)

<table>
<thead>
<tr>
<th>Item</th>
<th>Protein, %</th>
<th>VM, ppm</th>
<th>Average BW, lb (49 d)</th>
<th>Feed consumption (0 to 49 d), lb/bird</th>
<th>FCR (0 to 49 d), lb of feed/lb of BW</th>
<th>Mortality (0 to 49 d), %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment 1</td>
<td>17.1</td>
<td>0</td>
<td>6.98 ± 0.09</td>
<td>12.69 ± 0.15</td>
<td>1.82 ± 0.01</td>
<td>1.71 ± 0.97</td>
</tr>
<tr>
<td>Experiment 1</td>
<td>16.0</td>
<td>0</td>
<td>6.98 ± 0.12</td>
<td>13.01 ± 0.14</td>
<td>1.87 ± 0.02</td>
<td>2.20 ± 0.99</td>
</tr>
<tr>
<td>Experiment 1</td>
<td>16.0</td>
<td>15</td>
<td>7.11 ± 0.05</td>
<td>13.03 ± 0.10</td>
<td>1.83 ± 0.01</td>
<td>1.22 ± 0.33</td>
</tr>
<tr>
<td>P &gt; F</td>
<td>0.5037</td>
<td></td>
<td>0.1484</td>
<td>0.0657</td>
<td>0.5042</td>
<td></td>
</tr>
<tr>
<td>Experiment 2</td>
<td>17.1</td>
<td>0</td>
<td>7.28 ± 0.06</td>
<td>13.49 ± 0.14</td>
<td>1.85 ± 0.01 b</td>
<td>4.39 ± 0.88</td>
</tr>
<tr>
<td>Experiment 2</td>
<td>15.0</td>
<td>0</td>
<td>7.17 ± 0.06</td>
<td>13.65 ± 0.14</td>
<td>1.90 ± 0.01 a</td>
<td>4.15 ± 1.03</td>
</tr>
<tr>
<td>Experiment 2</td>
<td>15.0</td>
<td>15</td>
<td>7.32 ± 0.05</td>
<td>13.67 ± 0.13</td>
<td>1.87 ± 0.01 b</td>
<td>2.93 ± 1.08</td>
</tr>
<tr>
<td>P &gt; F</td>
<td>0.2075</td>
<td></td>
<td>0.5858</td>
<td>0.0001</td>
<td>0.5476</td>
<td></td>
</tr>
</tbody>
</table>

Main effects

| 17.1 | 0 | 7.13 ± 0.06 | 13.09 ± 0.14 | 1.84 ± 0.007 b | 3.05 ± 0.71 |
| 16.0/15.0 | 0 | 7.08 ± 0.070 | 13.33 ± 0.12 | 1.89 ± 0.011 a | 3.17 ± 0.73 |
| 16.0/15.0 | 15 | 7.22 ± 0.04 | 13.35 ± 0.11 | 1.85 ± 0.008 b | 1.83 ± 0.64 |

ANOVA of pooled data

| Treatment | 0.1566 | 0.0790 | 0.0003 | 0.2510 |
| Experiment | 0.0002 | 0.0003 | 0.0006 | 0.0027 |
| Experiment × treatment | 0.7313 | 0.7813 | 0.9919 | 0.9143 |

a,bMeans without a common superscript within columns are significantly different ($P < 0.05$).

and ended on October 9, 2003, an extra-low nutrient density withdrawal diet (Table 1) was fed to the birds in treatments 2 and 3, and based on ingredient prices taken from Feedstuffs (November 3, 2003), the estimated feed cost savings per 2,000 lb of feed when comparing the diets for treatment 1 vs. 2 were $16.76. The experimental withdrawal diets were fed from 35 to 49 d. Chicks and feed were weighed by pen on d 0, 17, 35, and 49.

**RESULTS AND DISCUSSION**

There were no significant experiment × treatment interactions for any of the measured variables, so data from both experiments were pooled for statistical analysis. There were significant differences due to experiment for most variables. This only indicates that there were some differences in magnitude between the experiments. For instance, birds fed the standard control diet weighed 6.983 lb in experiment 1 but 7.283 lb in experiment 2. Both rates of growth were very good for 0 to 49 d, but chick source, time of year, and so on caused some differences in magnitude between experiments.

**Live Performance**

Overall, birds fed the low and extra-low nutrient density withdrawal diets plus VM gained more weight than those fed the standard withdrawal diet (Table 2). In both experiments, the birds fed VM had the lowest mortality. Although these differences may have been due merely to chance, differences in FCR were not.

The FCR were significantly improved by adding VM to the low and extra-low nutrient density withdrawal diets. The FCR of the birds fed the low and extra-low nutrient density withdrawal diets plus VM approached those of the birds fed the standard withdrawal diets.

**Processing Performance**

Processing performance results are shown in Table 3. The live weights of the randomly chosen birds followed the same trends as the entire populations, as did the chilled carcass weights. The live weights of the birds fed the low and extra-low nutrient density withdrawal diets plus VM were very similar to those of the birds fed the standard withdrawal diet, and they were heavier than those of the birds fed the low and extra-low nutrient density diets without VM. Breast muscle weights followed the same pattern as the live weights; birds fed the low and extra-low nutrient density withdrawal diets plus VM had heavier breast meat weights than those fed the low and extra-low nutrient density withdrawal diets without VM.
Table 3. Influence of nutrient levels with and without virginiamycin (VM) in extended withdrawal feeds on processing data (pooled data experiments 1 and 2)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>ME, kcal/lb</th>
<th>VM, ppm</th>
<th>Live weight, lb</th>
<th>Chill carcass weight, lb</th>
<th>Carcass yield, %</th>
<th>Breast muscle weight, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>17.1</td>
<td>1,460</td>
<td>7.64 ± 0.07</td>
<td>5.85 ± 0.06</td>
<td>76.47 ± 0.22</td>
<td>1.49 ± 0.02</td>
</tr>
<tr>
<td>2</td>
<td>16.0/15.0</td>
<td>1,435</td>
<td>7.49 ± 0.07</td>
<td>5.73 ± 0.06</td>
<td>76.49 ± 0.25</td>
<td>1.43 ± 0.02</td>
</tr>
<tr>
<td>3</td>
<td>16.0/15.0</td>
<td>1,435</td>
<td>7.75 ± 0.06</td>
<td>5.96 ± 0.05</td>
<td>76.89 ± 0.14</td>
<td>1.49 ± 0.02</td>
</tr>
<tr>
<td>P &gt; F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>17.1</td>
<td>1,460</td>
<td>6.33 ± 0.06</td>
<td>4.84 ± 0.04</td>
<td>76.40 ± 0.19</td>
<td>1.23 ± 0.02</td>
</tr>
<tr>
<td>2</td>
<td>16.0/15.0</td>
<td>1,435</td>
<td>6.24 ± 0.06</td>
<td>4.75 ± 0.05</td>
<td>76.17 ± 0.22</td>
<td>1.20 ± 0.02</td>
</tr>
<tr>
<td>3</td>
<td>16.0/15.0</td>
<td>1,435</td>
<td>6.28 ± 0.05</td>
<td>4.80 ± 0.04</td>
<td>76.41 ± 0.18</td>
<td>1.19 ± 0.02</td>
</tr>
<tr>
<td>P &gt; F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>17.1</td>
<td>1,460</td>
<td>6.99 ± 0.07</td>
<td>5.35 ± 0.06</td>
<td>76.44 ± 0.15</td>
<td>1.36 ± 0.02</td>
</tr>
<tr>
<td>2</td>
<td>16.0/15.0</td>
<td>1,435</td>
<td>6.86 ± 0.07</td>
<td>5.24 ± 0.05</td>
<td>76.33 ± 0.16</td>
<td>1.32 ± 0.02</td>
</tr>
<tr>
<td>3</td>
<td>16.0/15.0</td>
<td>1,435</td>
<td>7.01 ± 0.07</td>
<td>5.38 ± 0.06</td>
<td>76.65 ± 0.12</td>
<td>1.34 ± 0.02</td>
</tr>
<tr>
<td>ANOVA of average data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>0.0319</td>
<td>0.0138</td>
<td>0.2762</td>
<td>0.0266</td>
</tr>
<tr>
<td>Sex</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>0.0794</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiment</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>0.2610</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*abMeans without a common superscript within columns are significantly different (P < 0.05).

The increased breast meat in the low and extra-low nutrient density withdrawal diets plus VM-fed broilers was due to an increased bird weight (Table 3). The increases in breast meat yield due to added VM were only observed in the males in both experiments. The percentage yield data incorporates variability in breast muscle weights and BW, and it is much harder to detect differences with this type of data. The actual weights of breast muscle meat have the lowest standard errors and are the most reliable and therefore the ones presented in Table 3.

The fundamental question that producers need to have answered is: “How low in nutrient density can diets be with and without virginiamycin?” From this research, it appears that at least a 2% decrease in protein level (from 17 to 15%) and 25 kcal/lb is a reasonable answer to that question.

The results achieved in experiments 1 and 2 are comparable to what other researchers have observed in both chickens and turkeys [1–11]. The value of VM can be calculated in terms of reduced feed cost but also in terms of reduced mortality. Adding VM to the reduced nutrient density withdrawal diets resulted in a decrease in mortality of about 1% in both experiments (from ~3 to ~2%), and this is consistent with research reports and field observations [1–11, 13, 14]. It is more difficult to assign a value to the effect of VM to reduce the incidence of clinical and subclinical necrotic enteritis, but that too should be considered whenever the value of VM is evaluated.

It is a shortcoming of least-cost feed formulation techniques currently used by the industry that they do not typically consider performance resulting from diets of different costs [16, 17]. Least-cost diets should be least cost with respect to providing acceptable levels of performance, but the connection between diet cost and performance is not always made when there is pressure to reduce feed costs. Feed additives like VM should be evaluated in terms of their ability to improve feed utilization or other performance parameters like growth rate or their ability to reduced mortality and morbidity due to enhanced intestinal health. The indiscriminate use of cost-minimizing software for feed formulation is likely to lead to profit minimization as well.
CONCLUSIONS AND APPLICATIONS

1. The nutrient-sparing effects of VM were confirmed in both experiments.

2. Virginiamycin appears to be effective in sparing energy, protein (amino acids), as well as minerals. Sparing of the magnitude of at least 25 kcal/lb and 2% protein (from 17 to 15%) was confirmed by these studies.

3. The value of VM should be determined by its influence on live performance, especially FE and growth rate gains, and breast meat yields, as well as the savings realized from feed formulation through decreased feed nutrient levels. The higher the feed costs, the more important to consider the potential feed cost savings from inclusion of VM in the diet.

4. Virginiamycin, through its nutrient-sparing effects, can reduce the risk of problems from ingredient variability and suboptimal mixing. Poultry nutritionists can lower margins of safety for essential nutrients when diets are supplemented with VM.

REFERENCES AND NOTES


