Effect of Nutrient Intake Restrictions by Dietary Dilutions with Sand on Broiler Performance

Salem Al-Taleb* 

ABSTRACT

An experiment was conducted to determine growth and carcass characteristics of Lohman strain run broilers subjected to varying degree of dietary dilutions (nutrient intake restriction) from 14 to 21 days of age. Nutrient restrictions were achieved by feeding a starter diet diluted with 0 (T1), 10 (T2), 15(T3), and 20% (T4) of builder's sand on a weight basis. There were four replicates in each treatment and 50 chicks per each replicate. After completing 7 days of nutrient restriction, all birds received undiluted starter diet for 28 days, followed by a finisher diet to trial termination at 56 days of age.

Birds that were fed on the diluted diets exhibited reduced growth rate (P<0.05) at 21 days of age when compared with the control group. Complete growth compensation by all birds that previously received the diluted diets was attained by 56 days. Varying levels of nutrient restriction did not affect growth compensation. No significant differences in food conversion ratio between groups were observed except for T4 (20% sand) that was significantly higher than all other groups. Nutrient restriction reduced fat contents in liver, breast and thigh meat at 56 days, but the effect was not always significant, such significance was only noticed at 15% in liver and breast samples when compared to T1 and T2. Abdominal fat in restricted birds was significantly (P<0.05) reduced compared with the control group at the 56th day. Moreover, there was a significant (P<0.05) increase in bones length, thickness and strength of all broilers exposed to the dietary dilution at the 56th day of age when compared with the control. At the 56th day of age, length and empty weight of the digestive tract were significantly (P<0.05) different with respect to the same traits of the control group.

In conclusion, nutrient intake restriction was accomplished by diluting the diet with sand when broiler chicks were fed on such diet between 14 to 21 days of age to improve their performance.

Keywords: Broiler, Nutrient intake restriction, Sand, Compensatory growth, Carcass composition.

1. INTRODUCTION

Commercial broilers have been selected for fast growth rate for a number of years (Havenstein et al., 1994). However, recent research has shown that fast growth is often associated with abnormal skeleton development and sudden death syndrome (Lcasen and Summers, 1988; Cobel and Waldroup, 1990; Deaton, 1995). Feed and light restrictions during early life may be one of the possible ways to minimize these problems. Various early feed restriction strategies of broilers has resulted in less carcass fat, smaller abdominal fat, improved feed conversation, reduced incidence of leg abnormalities, reduced mortality and faster growth rate at 56 days of age (Plavnik and Hurwitz, 1985; Plavnik et al., 1986; Kien, 1999; Ibrahim and Al-Talib, 2002; Naji et al., 2003).

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In addition, feed cost accounts for about 75% of total production costs in broiler production (Ibrahim, 2000). This high feed cost emphasizes the need to improve feed utilization.

The objective of the present study was to evaluate the effect of early quantitative feed restriction on compensatory growth and carcass traits of commercial broilers.

2. MATERIALS AND METHODS

Eight hundred (one-day old) Lohman strain run commercial broiler chicks were used in a completely randomized design. They were weighed and randomly assigned to four treatment groups. Four replicates of 50 chicks each were used in each treatment. The four feed restriction schemes utilized were: 1) ad libitum feeding (0% wt/wt sand) which served as the control, 2) 10% wt/wt sand, 3) 15% sand wt/wt sand, 4) 20% sand wt/wt sand. Dietary treatments were applied for 7 days from day 14 to day 21. Following restricted periods, all birds received full feeding until 56 days of age. Chicks were fed a corn-soybean meal-based starter diet from 1-28 days of age, followed by a finisher diet until their 56th day of age (Table 1). The diets were obtained from a commercial mill. According to the manufacturer, the diets contained 22% crude protein, 3100 Kcal (ME) metabolizable energy/kg and 20% crude protein, and 3200 Kcal ME/kg, respectively. Water was consumed ad libitum. Birds were reared on deep litter using gas brooders as the source of heat.

At the 56th day of age, 2 birds per replicate from each dietary treatment were taken for slaughter. In order to select a representative sample for slaughter, the mean body weight of birds taken for this purpose from each pen was the nearest to the overall mean body weight of each pen.

The liver, spleen, heart and abdominal fat were collected for weight determination. The digestive tract, extended from the pharynx to the cloaca including the pancreas, was weighed after removing the contents of the gizzard and flushing the rest of the tract with distilled water to remove the food residues. The length of the same digestive tract was measured.

On the 56th day of age, breast, thighs and drumsticks were weighed as separate carcass parts. To remove the legs, the skin between the body and thigh was cut at the hip joint. Drumsticks and thighs were weighted together. The breasts meat were separated by removing the wings at the shoulder joint and the neck close to the shoulder and the backs were separated from the breast along the vertebral column. Breast weight included the weight of bones of the pectoral girdle, sternum and ribs.

Eight samples of liver, breast and thigh were taken individually from each dietary treatment for the determination of dry matter, ash, fat, and protein (A.O.A.C, 1980). Results were expressed on dry matter basis.

Data were subjected to statistical analysis by one-way analysis of variance (SAS, 1991). Differences between treatment means were assessed for significance by the multiple F test (Duncan, 1955). Statistical significance was accepted at P<0.05.

3. RESULTS AND DISCUSSION

During the period of food restriction (day 14-21), the mean body weight of the chicks receiving the diets diluted with 10, 15 and 20% of sand was significantly (P<0.05) lower than that of the control group. However, when chicks returned to ad libitum feeding until the 56th day of age, the results indicated that birds subjected to a period of feed restriction were able to compensate for their depressed weight (Table 2), where body weight at the 56th day of age was significantly (P<0.05) higher than that of birds from the control group. As with respect to Food Conversion Ratio (FCR), the results indicated that there were no statistical differences in FCR between the control group T1 and those from treatment T2 (10% sand) and T3 (15% sand). However, FCR for birds from T4 (20% sand) was significantly lower (P<0.05) than that of birds from T1, T2, T3, respectively.

The results concerning organ weights and abdominal fat (Table 3) showed that feed restriction followed by a
period of ad libitum feeding until the age of 56 days of age caused some weight or length of the same organs when compared with the weight or length of the same organs of birds from the control group. Some of these differences were statistically significant (P<0.05) as indicated in table 3. However, restricted and refed birds had significantly (P<0.05) lower abdominal fat compared with the control group.

When examining the results concerning carcass parts and their chemical composition (Tables 4 and 5), statistical analysis indicated that some carcass parts of birds subjected to a 7 day period of feed restriction followed by a period of free access to feed until marketing age were significantly heavier (P<0.05) than birds from the control group, while others did not differ significantly when compared to those from the control group. Similar trend was observed with regard to chemical composition, dry matter, ash, fat and protein, in the carcass parts studied which included liver, breast and thigh meat.

The results of the study clearly demonstrate that compensatory growth occurred in broiler chicks following a period of decreased growth rate caused by dietary dilution by sand as a means of imposing quantitative feed restriction. This confirms the findings observed in other studies where birds were subjected to various methods of feed dilution or nutrient restriction (Plavnik and Hurwitz, 1985; Plavnik et al., 1986; Kieh, 1999; Ibrahim and Al-Taleb, 2002; Naji et al., 2003).

Birds that were fed on the diluted diets showed a significant decrease in abdominal and breast meat fat. These results were in agreement with those reported by other researchers (Beane et al., 1979; Plavnik and Hurwitz, 1985; Jones and Parrel, 1992a). Such a desirable response is of importance to the broiler producer, since it reflects a more desirable product for the consumer. It is also feasible that saving can be realized with the improved efficiency of growth and reduction in fat deposition.

An important consequence of diet dilution (nutrient restriction) other than the effects on internal organs and fat deposition may be the increase in the digestive tract weight and length in the respective broilers. The digestive tract of birds subjected to restricted feeding was significantly heavier and longer than that of birds from the control group. This modification could have contributed to the ability of the birds to achieve compensatory growth due to improving their efficiency in the digestive processes (Susbilla et al., 1994).

Broilers exposed to 20% sand treatment had a significant increase (P<0.05) in ash%, Ca% and P% in bones from thigh and drumstick compared to the other group (Table 6). There were no significant differences between broilers in groups that received 10 and 15% sand in term of thigh ash% and only Ca% in drumstick, but significantly differ (P<0.05) in the ash%. Moreover, broilers from groups that received 10% and 15% sand significantly differ (P<0.05) in P% in the thigh and drumstick bones (Table 6).

In general, the results of ash, Ca and P percentage in this experiment showed a significant (P<0.05) increase with increasing the percentage of sand in the broiler diets. This result may be caused by the high concentration of minerals in the sand. Bones from thigh and drumstick were tested for their length, thickness (Table 7) and strength (Table 8). The results of these tests showed a significant (p<0.05) increase in bones length, thickness and strength in the thigh and drumstick with increasing the level of sand in the broiler diet.

In conclusion, feed dilution with sand from 14 to 21 days of age lead to nutrient intake restriction in broiler chicks, that has resulted in its turn, in compensatory growth and better live weight at the 56th day of age.
Table 1. Composition of the starter and finisher diets.

<table>
<thead>
<tr>
<th>Ingredient (g/kg)</th>
<th>Starter</th>
<th>Finisher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground yellow corn</td>
<td>634.6</td>
<td>782.6</td>
</tr>
<tr>
<td>Dehulled soybean (46%CP)</td>
<td>220.3</td>
<td>180.1</td>
</tr>
<tr>
<td>Protein concentrate (52%CP)</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Salt</td>
<td>3.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Limestone</td>
<td>16.2</td>
<td>12.1</td>
</tr>
<tr>
<td>Dibasic calcium phosphate</td>
<td>12.3</td>
<td>6.4</td>
</tr>
<tr>
<td>Vitamin and mineral premix*</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>DL-Methionine</td>
<td>2.1</td>
<td>1.5</td>
</tr>
<tr>
<td>L-lysine</td>
<td>1.0</td>
<td>2.3</td>
</tr>
</tbody>
</table>

**Analytical Composition:**

- Protein (NX6.25)%: 22.3
- ME (Kcal/Kg): 2987

*The following were supplied per kilogram of diet: 12000 IU vitamin A; 2500 IU vitamin D3; 5mg riboflavin; 10 mg dicalcium pantothenate; 0.01mg vitamin B12; 3 mg vitamin K (menadione sodium bisulfate); 30 mg niacin; 1 mg folic acid; 0.2 mg biotin; 50 mg choline (choline chloride); 20 mg vitamin E; 3 mg pyridoxine HCl; 100 mg manganese oxide (60% Mn); 60 mg zinc oxide (80% Zn); 7.5 mg copper sulfate (25% Cu); 0.5 mg calcium iodate (65% I); 0.1 mg sodium selenite (45%Se); 120 mg ethoxyquin.

Table 2. The effect of early dietary dilution on body weight and feed conversion of broiler.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Day old (g)</th>
<th>Live body weight g</th>
<th>Feed conversion ratio g feed: g weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21 days (end of treatment period)</td>
<td>56 days</td>
<td></td>
</tr>
<tr>
<td>T1-0% Sand-control</td>
<td>41</td>
<td>506^c</td>
<td>2475.00^c</td>
</tr>
<tr>
<td>T2-10% Sand</td>
<td>41</td>
<td>458^a</td>
<td>2761.00^a</td>
</tr>
<tr>
<td>T3-15% Sand</td>
<td>41</td>
<td>427^a</td>
<td>2698.67^a</td>
</tr>
<tr>
<td>T4-20% Sand</td>
<td>41</td>
<td>401^a</td>
<td>2580.00^a</td>
</tr>
</tbody>
</table>

^c^ In each column, means bearing uncommon superscripts differ significantly (P<0.05).

Table 3. The effect of early dietary dilution on internal organ weight or length and abdominal fat contents of broilers at 56th day of age.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Digestive tract G cm</th>
<th>Liver G</th>
<th>Spleen G</th>
<th>Heart G</th>
<th>Gizzard G</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-0% Sand-control</td>
<td>196.86^c</td>
<td>213.00^c</td>
<td>39.44^c</td>
<td>2.60^c</td>
<td>10.60^b</td>
</tr>
<tr>
<td>T2-10% Sand</td>
<td>225.25^c</td>
<td>227.80^c</td>
<td>45.75^b</td>
<td>3.25^b</td>
<td>12.25^a</td>
</tr>
<tr>
<td>T3-15% Sand</td>
<td>223.13^b</td>
<td>235.60^b</td>
<td>44.38^a</td>
<td>3.63^a</td>
<td>10.00^b</td>
</tr>
<tr>
<td>T4-20% Sand</td>
<td>243.82^a</td>
<td>243.10^a</td>
<td>46.40^a</td>
<td>3.25^b</td>
<td>10.63^b</td>
</tr>
</tbody>
</table>

^c^ In each column, means bearing uncommon superscripts differ significantly (P<0.05).
Table 4: The effect of early dietary dilution on various broiler carcass cuts at the 56th day of age.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Wings (g)</th>
<th>Legs (g)</th>
<th>Carcass cuts weight g</th>
<th>Neck (g)</th>
<th>Back (g)</th>
<th>Breast (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-0% Sand</td>
<td>210.54b</td>
<td>480.38c</td>
<td>135.95d</td>
<td>427.6b</td>
<td>455d</td>
<td></td>
</tr>
<tr>
<td>T2-10% Sand</td>
<td>229.6a</td>
<td>571.75a</td>
<td>139.5c</td>
<td>428.63b</td>
<td>563.13a</td>
<td></td>
</tr>
<tr>
<td>T3-15% Sand</td>
<td>206.25c</td>
<td>542.12b</td>
<td>142.13b</td>
<td>430.63a</td>
<td>479.63b</td>
<td></td>
</tr>
<tr>
<td>T4-20% Sand</td>
<td>210.38b</td>
<td>499.45a</td>
<td>144.62a</td>
<td>425.6c</td>
<td>468.13c</td>
<td></td>
</tr>
</tbody>
</table>

*a-c* In each column, means bearing uncommon superscripts differ significantly (P<0.05)

Table 5: The effect of early dietary dilution on chemical composition of liver, thigh and breast meat of broilers at the 56th day of age.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Protein</th>
<th>Fat</th>
<th>Ash</th>
<th>Protein</th>
<th>Fat</th>
<th>Ash</th>
<th>Protein</th>
<th>Fat</th>
<th>Ash</th>
<th>Liver</th>
<th>Fat</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-0% Sand-control</td>
<td>46.26a</td>
<td>47.00a</td>
<td>3.59b</td>
<td>43.72c</td>
<td>48.83a</td>
<td>4.05a</td>
<td>67.08a</td>
<td>23.26a</td>
<td>4.15b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2-10% Sand</td>
<td>48.00a</td>
<td>45.10ab</td>
<td>3.75ab</td>
<td>44.61b</td>
<td>48.77a</td>
<td>4.22b</td>
<td>69.21b</td>
<td>22.16a</td>
<td>4.33ab</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3-15% Sand</td>
<td>48.74a</td>
<td>44.78b</td>
<td>4.11a</td>
<td>45.83a</td>
<td>48.67a</td>
<td>4.57a</td>
<td>69.44b</td>
<td>21.13b</td>
<td>4.63a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T4-20% Sand</td>
<td>48.80a</td>
<td>43.32c</td>
<td>4.26a</td>
<td>45.84a</td>
<td>47.28a</td>
<td>4.58a</td>
<td>69.58b</td>
<td>20.13b</td>
<td>5.06a</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a-c* In each column, means bearing uncommon superscripts differ significantly (P<0.05)

Table 6: The effect of early dietary dilution on ash, calcium and phosphorus percentage in thigh and drumstick bones of broilers at the 56th day of age.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ash (%)</th>
<th>Thigh</th>
<th>Ca (%)</th>
<th>P (%)</th>
<th>Ash (%)</th>
<th>Drumstick</th>
<th>Ca (%)</th>
<th>P (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-0% Sand-control</td>
<td>31.7±0.7a</td>
<td>31±1c</td>
<td>12.0±3a</td>
<td>32.3±1a</td>
<td>30.3±5c</td>
<td>11.9±3c</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2-10% Sand</td>
<td>33.02±0.8b</td>
<td>33.9±9b</td>
<td>12.9±3b</td>
<td>34.9±9b</td>
<td>31.6±5a</td>
<td>12.5±3b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3-15% Sand</td>
<td>33.4±0.7b</td>
<td>33.2±1b</td>
<td>13.3±4b</td>
<td>36.7±1.2a</td>
<td>32.15±4a</td>
<td>13.2±4a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T4-20% Sand</td>
<td>34.8±1c</td>
<td>37.3±1c</td>
<td>14.3±7d</td>
<td>38.1±1.4a</td>
<td>36.1±9b</td>
<td>14.2±4d</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a-c* In each column, means bearing uncommon superscripts differ significantly (P<0.05)

Table 7: The effect of early dietary dilution on drumstick and thigh length and thickness at the 56th day of age.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>DS length</th>
<th>DS thickness</th>
<th>T thickness</th>
<th>T thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-0% Sand-control</td>
<td>11.15±0.129</td>
<td>0.7375±0.025</td>
<td>8.575±1.171</td>
<td>0.8600±0.029</td>
</tr>
<tr>
<td>T2-10% Sand</td>
<td>11.85±0.125</td>
<td>0.8325±0.022</td>
<td>8.950±0.129</td>
<td>1.0025±0.082</td>
</tr>
<tr>
<td>T3-15% Sand</td>
<td>12.35±0.125</td>
<td>0.8950±0.013</td>
<td>9.325±0.171</td>
<td>1.2750±0.171</td>
</tr>
<tr>
<td>T4-20% Sand</td>
<td>13.30±0.216</td>
<td>1.0500±0.129</td>
<td>9.650±0.129</td>
<td>1.6500±0.129</td>
</tr>
</tbody>
</table>

Means with different superscripts in the same column are significantly different at probability level (P<0.05).

Table 8: The effect of early dietary dilution on the drumstick and thigh strength at the 56th day of age.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Thigh</th>
<th>Drumstick</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-0% Sand-control</td>
<td>170.1d</td>
<td>124.0d</td>
</tr>
<tr>
<td>T2-10% Sand</td>
<td>197.9c</td>
<td>138.3c</td>
</tr>
<tr>
<td>T3-15% Sand</td>
<td>210.4b</td>
<td>154.4b</td>
</tr>
<tr>
<td>T4-20% Sand</td>
<td>225.5a</td>
<td>169.1a</td>
</tr>
</tbody>
</table>

Means with different superscripts in the same column are significantly different at probability level (P<0.05).
REFERENCES


تأثير إضافة مستويات مختلفة من الرمل إلى علف الدجاج اللاحم على الأداء العام

سالم الطالب

ملخص

تم إجراء تجربة لتحديد نمو ومواصفات ذبائح الدجاج اللحمي (أرمن) التي تمت تقديمها على مستويات مختلفة من الرمل في حياتها المبكرة. تم التغلب على تحديات المغذي من خلال النطاق بواسطة الغذاء البدائي الذي أعطيته للدجاج في البداية، وحددت الرمل بمقترحات 1% (العملة 1) و10% (العملة 2) و15% (العملة 3) و20% (العملة 4) من أوزان رمل الباء.

تم استخدام أربع مardingات عالية مع أربعة مكورات لكل مارية وبواقع خمسين صبياً لكل مكرر، كل منها تتضمن تغذية لفترة 7 أيام، وبدأت في عمر 14-21 يوماً. وبعد اكتمال الأداء، تمت تكوين كافة الطيور عشاء غير مخفف، وفترة 28 يوماً، دونها غداء نهائي وحتى نهاية التجربة عند 56 يوماً من العمر.

أظهرت كافة الطيور التي تم تقديمها تغذية موفقة لمعدل نمو متأخراً (P≤0.05) عند مقاطرها مع مجموعة المقارنة.

إن تغذية الرمل الكامل كافية الطيور التي تتم تقديمها على غداء مخفف قد تحققت عند 56 يوماً من عمرها. إن المستويات المختلفة لتحديد الغذاء لم تؤثر في تغذية الرمل. ووجدت كذلك عدم وجود اختلافات معينة في نسبة تحويل الغذاء بين المجموعات باستخدام المعدل 4 (20% رمل). إن تخفيض الرمل لم يقل مستويات الدهون في الدجاج ولم يقل عند 56 يوماً، ولكن التأثير لم يكن دافعاً معيناً، وظل ذلك التأثير المعروفي الذي تمت ملاحظته للمعدل 3 (15%) في عيدات التكاثر والصدور عند مقاطرة مع المعدل 1 والمعدل 2. الشرك البياني في الطيور تحت التغذية كان معروفاً (P<0.05) وقد اختزل مقابلة مع مجموعة البيطرة عند 56 يوماً. علاوة على ذلك، كانت هناك زيادة معروفة (P<0.05) في طول العظام ومسكها ووزنها في الفخذ والقصبة مع زيادة مستوى الرمل في غداء الدجاج اللحمي عند 56 يوماً من العمر. عند عمر 56 يوماً فإن طول الفئة الهجمية ووزنها مقارنة كانت معروفاً (P<0.05) مقابلة مع ذلك في مجموعة المقارنة.

ويلاحظ، فإن تحليل الغذاء من خلال استخدام الرمل في علف الدجاج لاحم في أعماره الأولية يمكن أن يحسن الأداء.

الكلمات النهاية: لحم، عناصر غذائية، تدريج، رمل، النمو، الأذناء.

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